STANDARD BOLT AND SCREW INSTALLATION

1. General

Standard screws, bolts, and nuts removed in maintenance must be properly torqued. The torque moment must be accurately controlled; overtightening may damage the threads or bolt and cause failure, undertightening may reduce the fatigue life of the fastener. An approved calibrated torque wrench shall be used.

CHAPTER 13

STANDARD PRACTICES - AIRFRAME

1. General

   Sections 13-1-0 and 13-2-0 list the usage data for various paints, primers, sealants, adhesives and cements. Unless specific mixing instructions and curing times are given, all mixing and curing shall be accomplished as directed by the manufacturer on the kit label. Shelf life periods should be carefully observed and all overage kits or partially used kits with illegible labels should be discarded.

STANDARD BOLT AND SCREW INSTALLATION - MAINTENANCE PRACTICES

1. General

When tightening bolt-nut combinations always torque the nut unless absolutely impractical to do so. If impractical to torque nut; check torque required to turn bolt, after full thread engagement, and add this to the value found in table (see Figure 201). Use this corrected value for final torquing at bolthead.

2. Equipment Required

A. Calibrated torque wrench and suitable adapters.

B. Anti-seize compound Specification P-51 (For aluminum bolts only), Armite Laboratories, Los Angeles, Calif.

C. Grease graphite, Specification MIL-G-7187 (For titanium bolts in steel threads).

3. Placement of Bolts

Whenever practical bolts shall be placed as follows:

A.

Direction of bolt	Placement of bolthead
Up-and-down	Upward
Forward-and-aft	Forward
Inboard-and-outboard	Inboard

B. Junction box mounting bolts shall be placed with bolthead inside the box to preclude the possibility of loose nuts and washers shorting across terminals.

C. Bolt and screw heads shall be placed outside junction box covers; and, wherever practical, on the airplane's exterior.

4. Self-Locking Nuts

A. Self-locking nuts one-quarter-inch or less shall not be used on bolts drilled for cotter pins.

B. Self-locking nuts five-eighths-inch or larger may be used on bolts drilled for cotter pins providing:

(1) Drilled hole is beyond the load zone of the nut.

(2) Sharp burrs around the cotter pin hole are dressed out smooth when fiber insert nuts are used.

5. True Torque Values (See Figure 201)

Approved torque values for AN type bolts and nuts are tabulated on Figure 201. Special torque values are included in applicable chapters of this manual. The table lists true torque values for bolts and nuts which turn freely after full thread engagement. Steel threads are lubricated only when titanium bolts are used.

SIZE	THREADS PER INCH	STEEL (ALSO APPLICABLE TO TITANIUM BOLTS IN STEEL THREADS)								ALUMINUM			
		AN310, AN363 AN365, NU220 NAS679, NAS1291 MS20500		NAS1291 NU32 NU222		AN320 AN364 NU220		NAS1291		AN310 AN365		AN320 AN364	
		IN. LBS.	FT. LBS.	IN. LBS.	FT. LBS.	IN. LBS.	FT. LBS.	IN. LBS.	FT. LBS.	IN. LBS.	FT. LBS.	IN. LBS.	FT. LBS.
10	32	20-25	...	...	...	12-15	...	40-50	...	...	...	...	...
1/4	28	50-70	...	75-105 (SEE NOTE 1)	...	30-40	...	100-140 (SEE NOTE 2)	...	20-35	...	27-34	...
5/16	24	100-140	9-12	150-210 (SEE NOTE 1)	13-18	60-85	5-7	200-280 (SEE NOTE 2)	16-23	50-75	4-6	40-55	4-5
3/8	24	160-190	13-16	240-285 (SEE NOTE 1)	20-24	95-110	8-9	320-380 (SEE NOTE 2)	26-32	80-110	7-9	65-85	6-7
7/16	20	450-500	38-42	675-750 (SEE NOTE 1)	57-63	270-300	23-25	900-1000 (SEE NOTE 2)	75-83	100-140	9-11	85-110	7-9
1/2	20	480-690	40-57	720-1035 (SEE NOTE 1)	60-85	290-410	24-34	960-1380 (SEE NOTE 2)	80-115	170-220	14-18	125-155	11-13
9/16	18	800-1000	67-83	1200-1500 (SEE NOTE 1)	100-125	480-600	40-50	1600-2000 (SEE NOTE 2 & 3)	133-167	...	...	...	...
5/8	18	1000-1300	92-108	1650-1950	138-162	660-780	55-65	2200-2600 (SEE NOTE 3)	183-216	400-460	34-38	235-300	20-25
3/4	16	2300-2500	192-208	3450-3750	288-312	1300-1500	109-125	4600-5000 (SEE NOTE 3)	382-416	...	...	490-630	41-52
7/8	14	2500-3000	209-250	3750-4500	312-375	1500-1800	125-150	5000-6000 (SEE NOTE 3)	416-500	...	...	...	...
1	14	3700-5500	308-458	5550-8250	462-687	2200-3300	184-275	7450-11000 (SEE NOTE 3)	620-916	...	...	...	...
1-1/8	12	5000-7000	417-583	7500-10500	625-875	3000-4200	250-350	...	...	...	...	...	...
1-1/4	12	9000-11000	750-916	13500-16500	1125-1375	5400-6600	450-550	...	...	...	...	...	...

NOTE:

1. APPLICABLE TO NAS1291 NUTS WHEN USED ON MS20004 THRU MS20024 BOLTS.
2. APPLICABLE TO NAS1291 NUTS WHEN USED ON BOLTS EWB22-4 THRU -6 (STANDARD PRESSED STEEL CO., JENKINTOWN, PA.)
3. TORQUE VALUES NOT APPLICABLE WHEN PRE-LOAD, INDICATING WASHERS ARE USED.
4. APPLY GREASE SPECIFICATION MIL-G-7187, ON TITANIUM BOLTS BEFORE INSTALLING IN STEEL THREADS
5. APPLY ANTI-SEIZE COMPOUND P-51 ON ALUMINUM THREADS

WHEN USING TORQUE WRENCH ADAPTERS, IF THE DESIRED TORQUE IS KNOWN, THE TORQUE WRENCH DIAL READING MAY BE FOUND AS FOLLOWS:

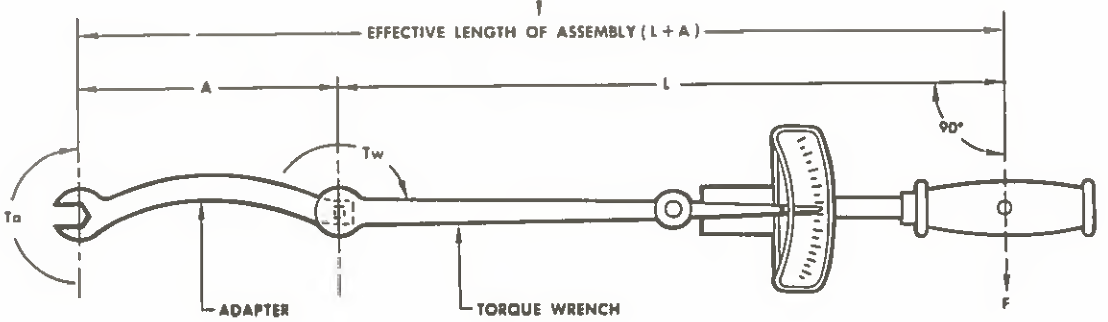
T_w = WRENCH DIAL READING.

T_a = DESIRED TORQUE AT END OF ADAPTER.

L = LEVER LENGTH OF TORQUE WRENCH.

A = LENGTH OF ADAPTER (CENTER DISTANCE).

FORMULA — $T_w = \frac{T_a \times L}{L + A}$



22 03 13 015D

Standard Bolt Torque Values
Figure 201

True torque values for bolts and nuts, which do not turn freely after full thread engagement, are obtained by: first finding the torque required to turn the fully engaged bolt or nut, then adding this torque to the value found in the table for final torquing.

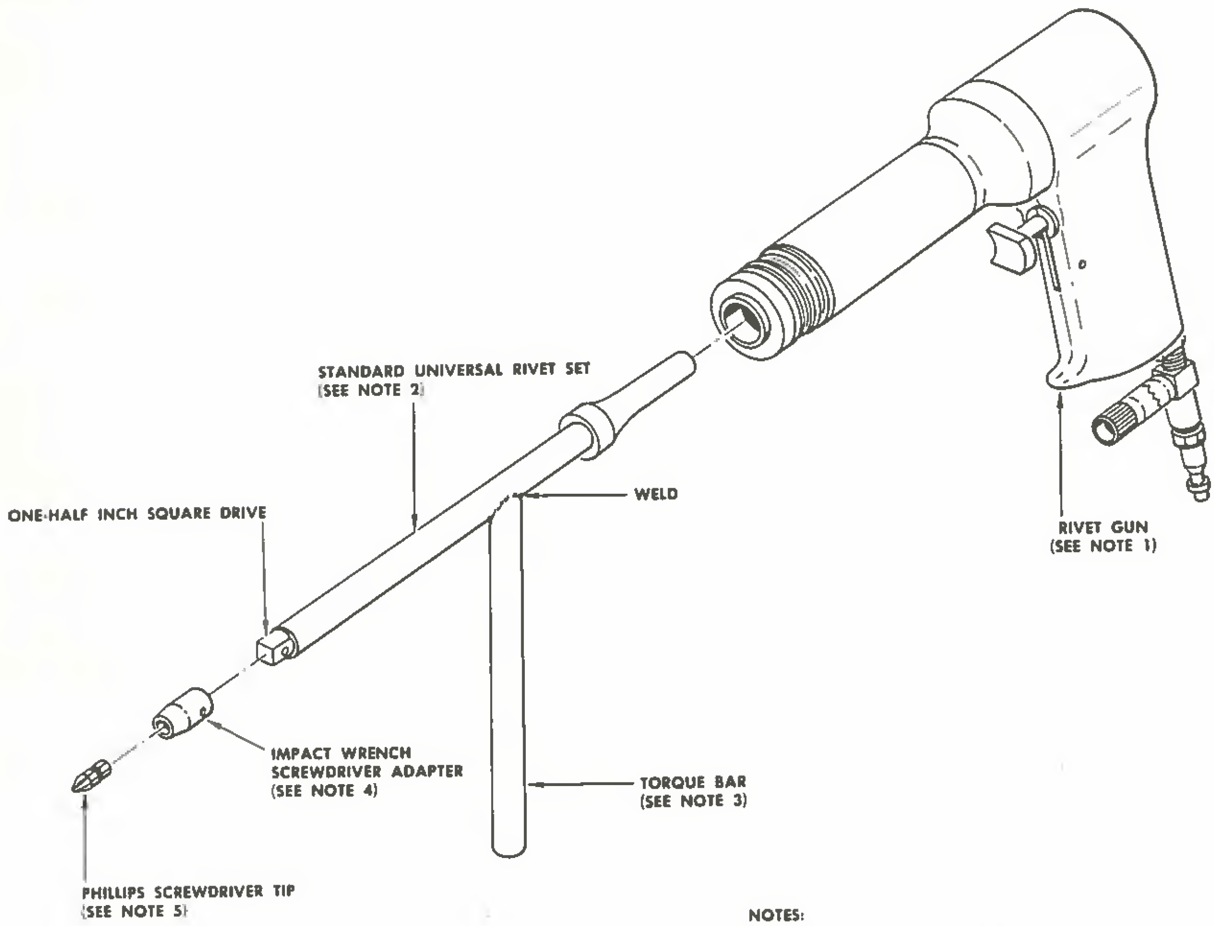
When using torque wrench adapter, true torque values are found by application of the formula found on Figure 201.

A tool for removing frozen screws is shown on Figure 202.

FROZEN SCREW REMOVAL PROCEDURE

1. INSERT MACHINED RIVET SET WITH ATTACHED TORQUE BAR INTO RIVET GUN.
2. PLACE SCREWDRIVER ADAPTER OVER MACHINED END OF RIVET SET.
3. INSERT PHILLIPS SCREWDRIVER TIP INTO SCREWDRIVER ADAPTER.
4. CONNECT AIR SUPPLY.
5. ENGAGE PHILLIPS SCREWDRIVER TIP WITH FROZEN SCREW.
6. PRESS TRIGGER ON RIVET GUN AND TORQUE BAR TO REMOVE FROZEN SCREW.

   NOTE:
   KEEP PHILLIPS SCREWDRIVER TIP PRESSED FIRMLY AGAINST SCREW WHILE AIR PRESSURE IS ON.



NOTES:

1. CP-4X RIVET GUN OR A RIVET GUN OF EQUAL STRENGTH.
2. STANDARD UNIVERSAL RIVET SET 7 INCHES LONG WITH DRIVEN END MACHINED TO ½-INCH SQUARE TO FIT IMPACT WRENCH ADAPTER.
3. TORQUE BAR. PREFERABLY MADE FROM ½-INCH STEEL TUBE FOR WELDING AND STRENGTH PURPOSES.
4. SCREWDRIVER ADAPTER FROM INGERSOLL-RAND 504 IMPACT WRENCH.
5. STANDARD PHILLIPS SCREWDRIVER TIP.

Frozen Screw Removal
Figure 202

PRE-LOAD INDICATING WASHER INSTALLATION - MAINTENANCE PRACTICES

1. General

Pre-load indicating washer sets are used on nut and bolt installation throughout the airplane. Each pre-load indicating washer set consists of; one inner PLI washer, one outer PLI washer, and two close-tolerance, heat-treated flat washers. The PLI washer set is placed between the material and the nut. As the nut is tightened, it compresses the inner washer, which is thicker than the outer washer, until the outer washer cannot be moved.

Holes in the edge of the outer PLI washer permits testing with a small lever while tightening the nut.

2. Equipment Required

A. Feeler gage (0.002 inch).

B. Hardened steel hand lever (NO. 52 or NO. 53 drill rod or equivalent).

NOTE: Do not use a paper clip or other wire.

3. Installation of PLI Washer (See Figure 201)

A. Visually check bolt holes for burrs and chips.

B. Remove all chips and burrs from bolt hole.

C. Determine that PLI washer set to be used is correct size.

D. Place PLI washer set on bolt, under nut.

NOTE: Close tolerance flat washers are of special design. Do not substitute.

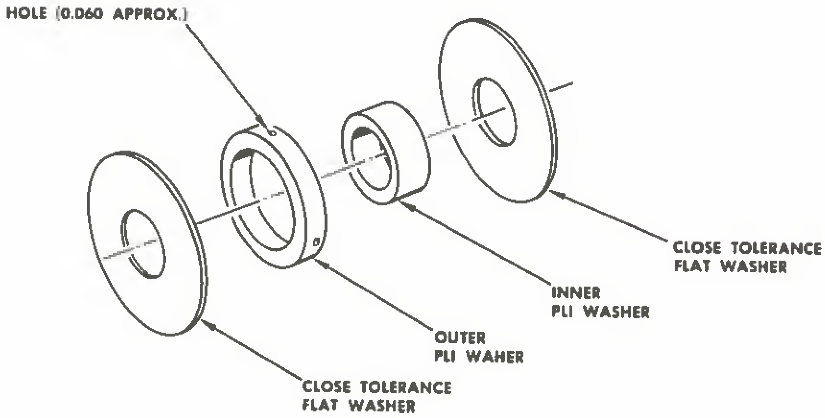
E. Insert the small hardened steel lever in a hole in the outer washer (see Figure 201).

F. While turning outer PLI washer with the lever, gradually tighten the nut. When the outer PLI washer ceases to rotate, stop tightening the nut.

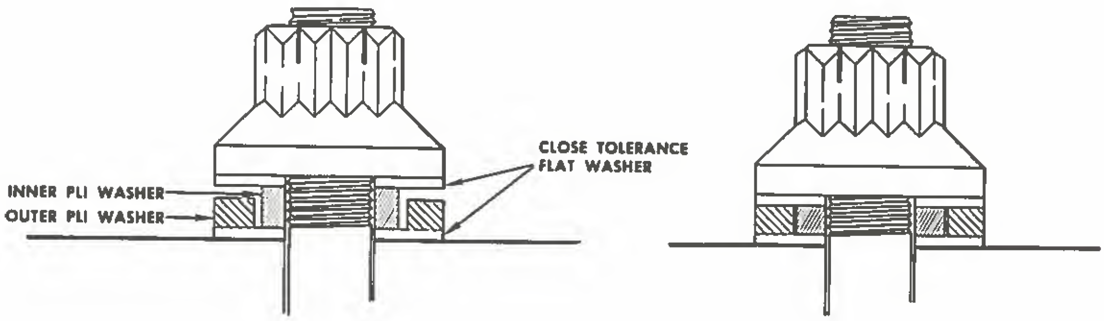
G. Change lever to another hole in the outer PLI washer and apply hand pressure. If washer moves, tighten nut until washer will not move.

CAUTION: DO NOT TIGHTEN NUT BEYOND POINT WHERE OUTER PLI WASHER CANNOT BE MOVED.

H. Check for gaps between faying surfaces of washers, structure, or nut.



NOTE: AS THE NUT OR BOLT IS TIGHTENED, THE INNER WASHER COMPRESSES UNTIL THE OUTER WASHER CAN NO LONGER BE MOVED. WHEN THIS OCCURS, THE DESIRED PRELOAD ON THE BOLT HAS BEEN OBTAINED.



BEFORE TIGHTENING NUT

NUT TIGHTENED TO DESIRED PRELOAD

CAUTION

DO NOT OVER-TIGHTEN. DO NOT USE TORQUE WRENCH. OVER-TIGHTENED, LOOSENED, OR REMOVED PLI WASHER SETS MUST BE REPLACED.

PRE-LOAD INDICATING (PLI) WASHER INSTALLATION

22.02 13.015

NOTE: No gaps are permitted between close tolerance flat washer and nut, or between close tolerance flat washer and structure. It is permissible to have gaps between one close tolerance flat washer and the outer PLI washer which will permit a 0.002 inch maximum feeler gage to contact inner PLI washer, provided a minimum of 50% of the outer PLI washer circumference is in full bearing.

I. If gaps exceed those permitted in the above NOTE, remove PLI washer set. Replace PLI washer set and repeat steps 3.D. through H.

CAUTION: DO NOT OVER-TIGHTEN. DO NOT TORQUE TEST. OVER-TIGHTENED, LOOSENED, OR REMOVED PLI WASHER SETS MUST BE REPLACED.

SPLIT CONE BUSHINGS - MAINTENANCE PRACTICES

1. Removal/Installation Split Cone Bushings (see Figure 201)

   Split cone bushings are used with tapered outer bushings to provide bolt support, prevent bolt rotation, minimize friction, and to ensure sound hinges on airplane control surfaces.

   A. Equipment Required.

      (1) Calibrated torque wrench and suitable adapters.

      (2) Feeler gage (0.005 inch).

      (3) Washers (oversize).

      (4) Support blocks (fabricate locally).

      (5) Wrench socket set.

   B. Remove Split Cone Bushing.

      (1) Improvise puller with bolt, oversize wrench socket, washers, and nut.

      (2) Install oversize wrench socket over wide end of tapered bushing so socket lip rests on hinge lug.

      (3) Insert bolt with undersize washer at head through narrow end of tapered bushing.

      (4) Install washer and nut on bolt end protruding through socket. Tighten nut to remove split cone bushing.

   C. Install Split Cone Bushing.

      (1) Align hinge fittings, and install support blocks between bearing surface and hinge lugs.

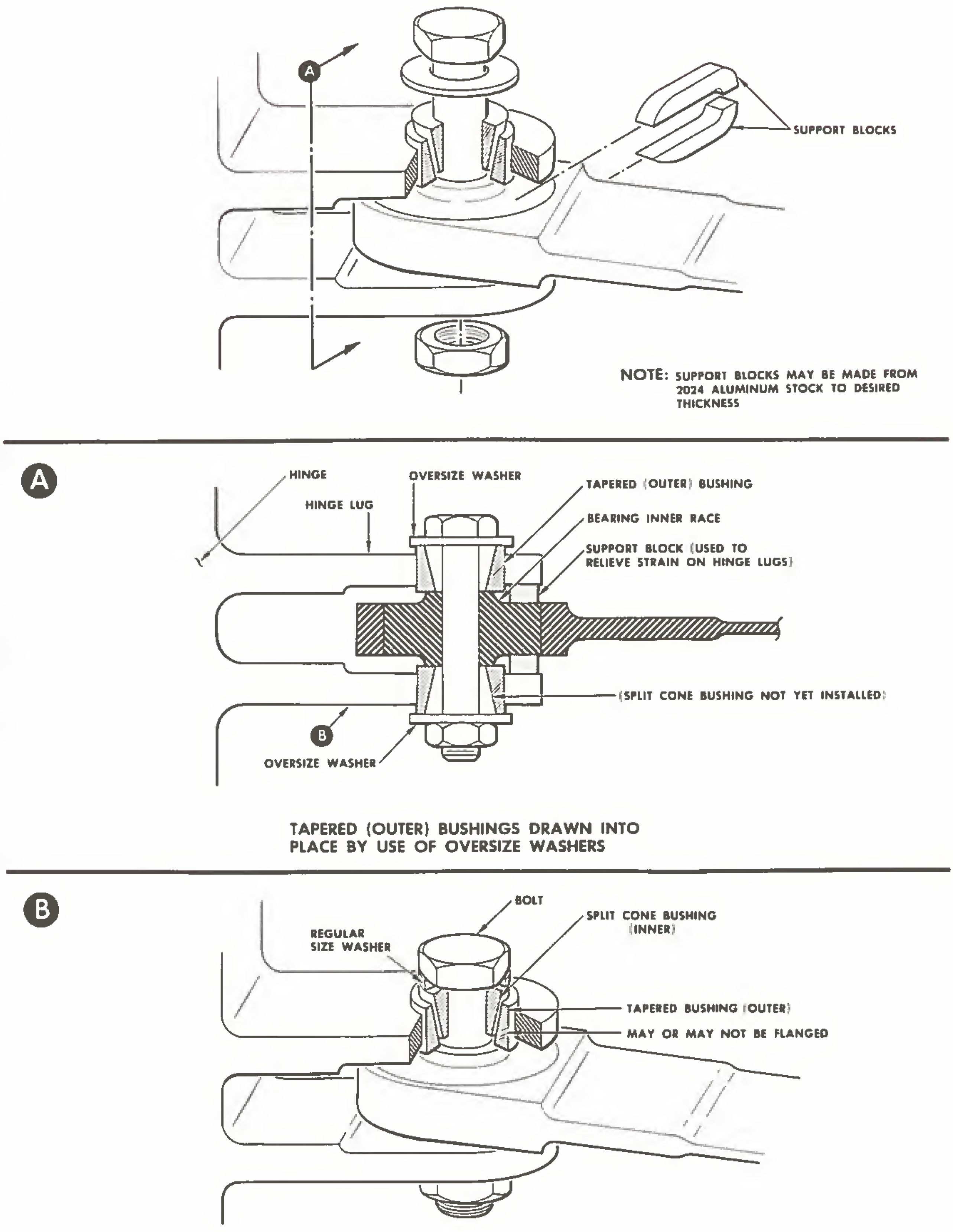
         CAUTION: SUPPORT BLOCKS MUST BE USED DURING SET-UP OF TAPERED (OUTER) BUSHINGS FOR SUPPORT OF HINGE LUGS TO PREVENT CRACKING.

      (2) Install tapered (outer) bushings, bolt, oversize washers, and nut.

      (3) Tighten nut to torque value specified in section 13-3-1.

      (4) Remove bolt and support blocks.

         NOTE: The gap between hinge bushing and the bearing shall not exceed 0.005 inch after springback.



22.02.13.018

Split Cone Bushing Installation
Figure 201

(5) Apply graphite grease, Specification MIL-G-7187, to outside surface of each split cone bushing.

<u>CAUTION</u>: WHEN INSTALLED, THE HINGE BOLT AND INSIDE SURFACE OF THE SPLIT CONE BUSHING MUST BE CLEAN AND FREE OF GREASE.

(6) Insert split cone bushing in each tapered outer bushing.

(7) Align hinge fittings and install hinge bolt, washers, and nut.

(8) Tighten nut to torque value specified in section 13-3-1.

ELECTRICAL FEEDTHRUS

1. General

Pressure-tight electrical feedthrus are installed throughout the airplane in areas where electrical wires must pass through air pressure-tight webs or panels. Fuel-tight electrical feedthrus are installed in areas where wires must pass through fuel tank walls. They consist of pigtail wires which pass through and are embedded in hermetically sealed fittings. Typical removal/installation procedures for pressure-tight and fuel-tight feedthrus are presented in this section.

ELECTRICAL FEEDTHRUS - MAINTENANCE PRACTICES

1. Removal/Installation Pressure-Tight Electrical Feedthru (See Figure 201)

A. Equipment Required.

(1) EC-1293 sealant or equivalent, 3M Co., St. Paul 6, Minn. Mix and cure per manufacturer's instructions on kit.

B. Remove Feedthru.

CAUTION: OPEN APPLICABLE CIRCUIT BREAKER FOR FEEDTHRU TO BE REMOVED AND HANG WARNING SIGN ON THE CIRCUIT BREAKER.

NOTE: Bag and tag loose parts for installation.

(1) Remove clamps securing feedthru wires (not shown).

(2) Cut wires at the permanent splices on the opposite side to pressure feedthru. (Tag wires for installation.)

(3) Remove attaching screws (6), and washers securing feedthru.

(4) Remove feedthru from panel.

C. Install Feedthru.

(1) Select correct feedthru.

(2) Remove burrs and clean faying surface of panel.

(3) Mix EC-1293 sealant.

(4) Apply EC-1293 sealant to faying surfaces of panel, gasket, and to each attaching screw as directed in Chapter 51, STRUCTURES GENERAL.

(5) Position gasket on panel pressure side.

(6) Position feedthru in panel hole, pressure side.

(7) Align screw holes. Install screws with washers.

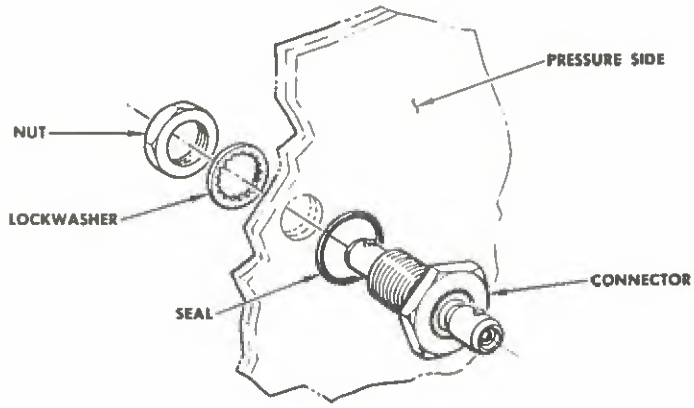
(8) Tighten screws evenly. Do not over-tighten.

(9) Pair-up wires and make permanent splices. (Refer to NOTES section of WIRING DIAGRAM MANUAL.)

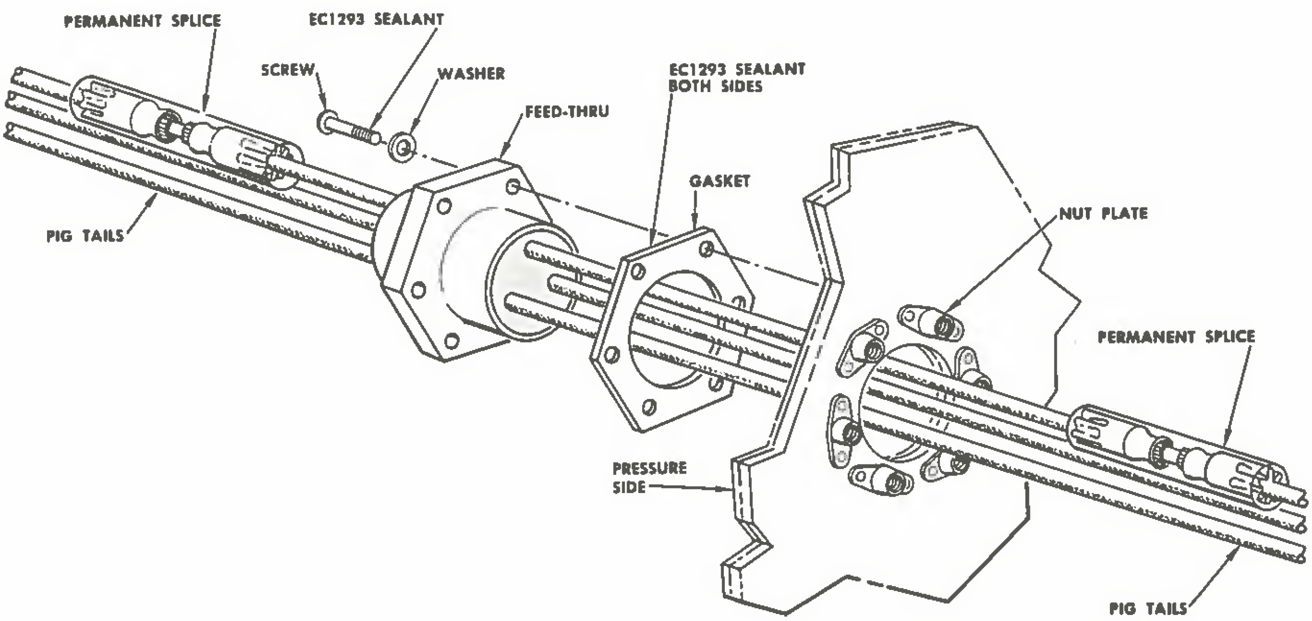
(10) Install clamps for securing wires.

(11) Reset circuit breaker and remove warning sign.

(12) Perform system test; refer to applicable systems' chapter in Maintenance Manual.



TYPICAL SINGLE WIRE FEED-THRU CONNECTOR INSTALLATION



TYPICAL MULTIPLE WIRE FEED-THRU INSTALLATION

22.02.13.016

Removal/Installation Pressure-Tight Electrical
Feedthru (Typical)
Figure 201

2. Removal/Installation Pressure-Tight Electrical Feedthru Connector (See Figure 201)

A. Equipment Required - None.

B. Remove Feedthru Connector.

CAUTION: OPEN APPLICABLE CIRCUIT BREAKER FOR FEEDTHRU CONNECTOR TO BE REMOVED AND HANG WARNING SIGN ON CIRCUIT BREAKER.

NOTE: Bag and tag loose parts for installation.

(1) Disconnect harness from connector by rotating lug counterclockwise.

(2) Remove nut and lock washer securing connector to bulkhead.

(3) Remove connector and seal from bulkhead.

C. Install Feedthru Connector.

(1) Remove burrs and clean faying surfaces of bulkhead.

(2) Position seal onto connector, and position connector in hole through bulkhead.

(3) Install lockwasher and nut on connector.

(4) Tighten nut. Do not over-tighten.

(5) Connect harness to feedthru connector, and tighten lug by rotating counterclockwise.

(6) Reset circuit breaker and remove warning sign.

(7) Perform system test; refer to applicable system's chapter in Maintenance Manual.

3. Removal/Installation Fuel-Tight Electrical Feedthru (See Figure 202)

A. Equipment Required - None.

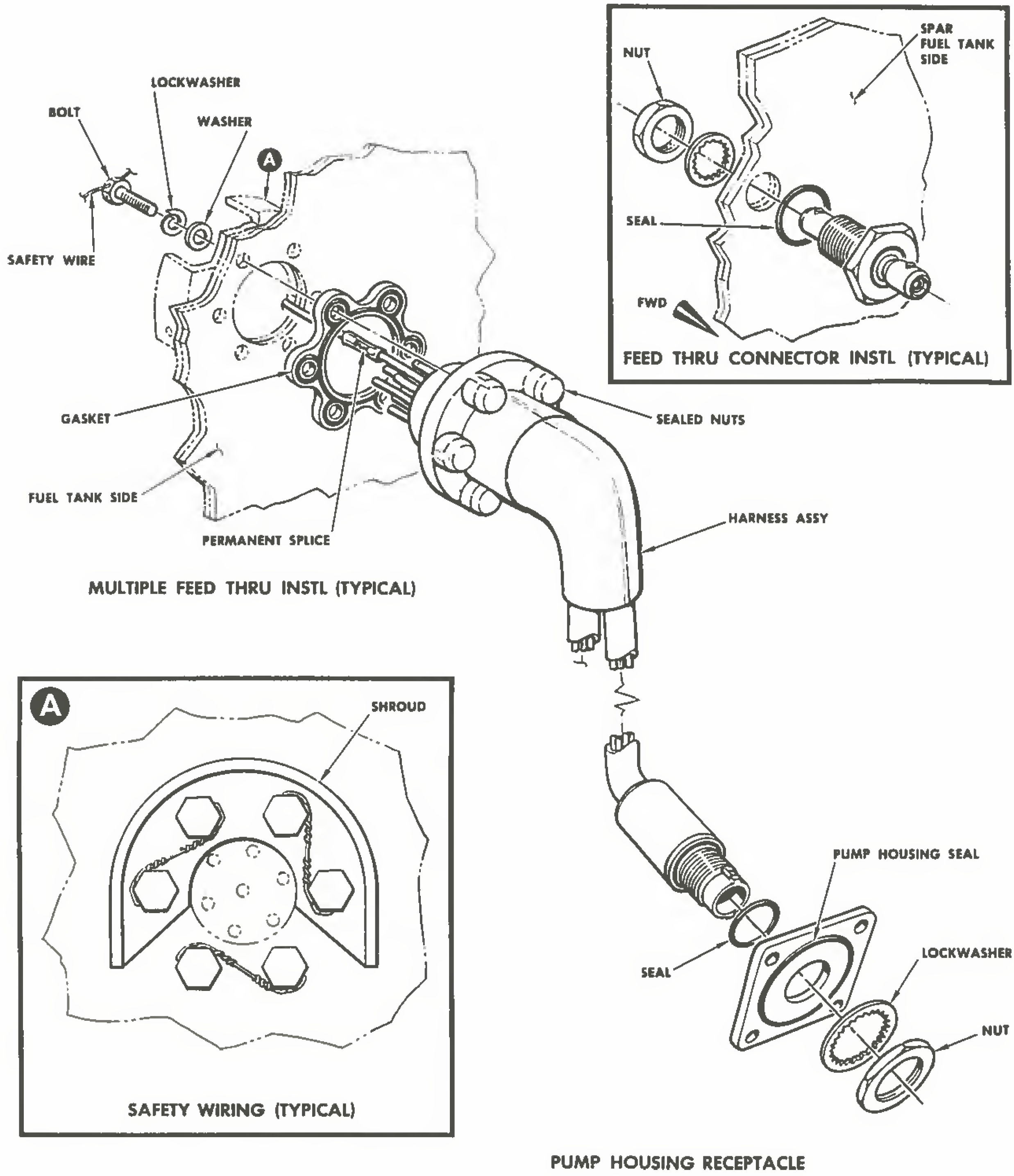
B. Prepare for Replacement of Feedthru.

(1) Defuel corresponding wing tank; refer to Chapter 12, SERVICING.

(2) Inert tank; refer to Chapter 28, FUEL TANKS.

(3) Remove access panel nearest feedthru.

WARNING: OBSERVE ALL FUEL TANK ENTRANCE PRECAUTIONS: REFER TO CHAPTER 28, FUEL TANKS.



22.02.13.017

Removal/Installation Fuel-Tight Electrical
Feedthru (Typical)
Figure 202

C. Remove Feedthru.

CAUTION: OPEN APPLICABLE CIRCUIT BREAKER FOR FEEDTHRU TO BE REMOVED AND HANG WARNING SIGN ON THE CIRCUIT BREAKER.

NOTE: Bag and tag loose parts for installation.

(1) Cut wires at permanent splices on the opposite side of feedthru. (Tag wires for installation.)

(2) Remove clamps securing harness. (not shown)

(3) Remove feedthru harness from fuel pump housing connection.

(a) Remove safety wire, screws, washers, and seal.

(b) Pull receptacle connector.

(4) Remove feedthru harness from fuel pump connection.

(a) Remove nut and lockwasher.

(b) Remove connector and seal.

(5) Remove feedthru from fuel tank.

(a) Remove safety wire, bolts, lockwashers, flat washer, and shroud. (Tag shroud for installation.)

(b) Remove feedthru, gasket, and nutplate.

D. Install Feedthru.

(1) Choose correct feedthru.

(2) Remove burrs and clean faying surface of bulkhead.

(3) Position gasket, feedthru, nut plate and shroud, and align bolt holes.

(4) Install shroud, flat washers, lock washers, and bolts.

NOTE: Check bolts for proper length.

(a) Tighten bolts evenly. Do not over-tighten.

(b) Safety wire bolts.

(5) Splice harness outboard wires, using permanent splices. (Refer to NOTES section of WIRING DIAGRAM MANUAL.)

(6) Connect harness to fuel pump.

(a) Position seal, place pump connector through the pump housing connector.

(b) Install lock washer and nut. Do not over-tighten.

(c) Connect pump receptacle.

(7) Connect harness to fuel pump housing.

(a) Position seal on housing connector.

(b) Align holes, install washers, and screws.

(c) Tighten screws evenly. Do not over-tighten.

(d) Safety wire screws.

(e) Install clamps securing harness.

(8) Install access panel.

(9) Reset circuit breaker and remove warning sign.

(10) Perform fuel pump test; refer to Chapter 28, FUEL TANKS.

4. Removal/Installation Fuel-Tight Electrical Feedthru Connector (See Figure 202)

A. Equipment Required - None.

B. Prepare for Replacement of Feedthru Connector.

(1) Defuel corresponding wing tank; refer to Chapter 12, SERVICING.

(2) Inert tank; refer to Chapter 28, FUEL TANKS.

(3) Remove access panel nearest feedthru connector.

WARNING: OBSERVE ALL FUEL TANK ENTRANCE PRECAUTIONS: REFER TO CHAPTER 28, FUEL TANKS.

C. Remove Feedthru Connector.

CAUTION: OPEN APPLICABLE CIRCUIT BREAKER FOR FEEDTHRU CONNECTOR TO BE REMOVED AND HANG WARNING SIGN ON THE CIRCUIT BREAKER.

NOTE: Bag and tag loose parts for installation.

(1) Disconnect harness from connector by rotating lug counterclockwise, and pull harness away.

(2) Remove attaching nut, seal, and connector from bulkhead.

D. Install Feedthru Connector.

(1) Choose correct feedthru connector.

(2) Remove burrs and clean faying surface of bulkhead.

(3) Position connector, seal, and nut.

NOTE: Seal must be on pressure side of bulkhead.

(4) Tighten nut. Do not over-tighten.

(5) Install harness lug by inserting lug onto connector.

(6) Rotate lug clockwise to tighten and secure.

(7) Install access panel.

(8) Reset circuit breaker and remove warning sign.

(9) Perform fuel pump test; refer to Chapter 28, FUEL TANKS.

TWA

LIST OF EFFECTIVE PAGES

Chapter 13
STANDARD PRACTICES - AIRFRAME

Chapter 13
STANDARD PRACTICES - AIRFRAME

TABLE OF CONTENTS

LIST OF EFFECTIVE PAGES

Chapter 21
AIR CONDITIONING

CHAPTER	PAGE	DATE	CODE
*21	i	July 25/62	B-5
*21	ii	July 25/62	B-5
*21	iii	July 25/62	B-5
*21	iv	July 25/62	B-5
*21	v	July 25/62	B-5
*21	vi	July 25/62	B
*21	1	July 25/62	B-4
*21	2	July 25/62	B-4
21	3	May 25/61	B-4
21	4	May 25/61	B-4
21	5	Dec. 5/60	B-3
21	6	Dec. 5/60	B-3
21	7	Dec. 5/60	B-3
21	8	May 25/61	B-4
21	9	May 25/61	B-4
21	10	Dec. 5/60	B-3
21	11	May 25/61	B-4
	BLANK		
21-0	1	Dec. 5/60	B-3
21-0	2	Dec. 5/60	A-3
21-0	3	Basic	A
21-0	4	Dec. 5/60	B-3
21-0	5	Dec. 5/60	B-3
21-0	6	May 25/61	B-4
21-0	101	May 25/61	B-4
21-0	102	May 25/61	B-4
21-0	103	May 25/61	B-4
21-0	104	May 25/61	B-4
21-0	105	May 25/61	B-4
21-0	106	May 25/61	B-4
21-0	107	May 25/61	B-4
21-0	108	May 25/61	B-4
21-0	109	May 25/61	B-4
21-0	110	May 25/61	B-4
21-0	111	May 25/61	B-4
21-0	112	May 25/61	B-4
21-0	201	May 25/61	B-4
21-0	202	May 25/61	B-4
21-0	203	Dec. 5/60	B-3
21-0	204	Dec. 5/60	B-3
21-0	205	Dec. 5/60	B-3
21-0	206	Dec. 5/60	B-3
21-0	207	May 25/61	B-4
21-0	208	Dec. 5/60	B-3
21-0	209	Dec. 5/60	B-3
21-0	210	Dec. 5/60	B-3
*21-0	211	July 25/62	B-5
*21-0	212	July 25/62	B-4
*21-0	213	July 25/62	B-4
*21-0	214	July 25/62	B-4
*21-0	215	July 25/62	B
*21-0	216	July 25/62	B
*21-0	217	July 25/62	B
*21-0	218	July 25/62	B
21-1-0	1	Dec. 5/60	B-3
21-1-0	2	Dec. 5/60	B-3
*21-1-0	3	July 25/62	A-5
*21-1-0	4	July 25/62	A-5
21-1-0	5	Dec. 5/60	A-3
*21-1-0	6	July 25/62	A-5
21-1-0	7	Dec. 5/60	A-3
*21-1-0	8	July 25/62	A-5
*21-1-0	9	July 25/62	A-4
21-1-0	10	Dec. 5/60	B-3
*21-1-0	11	July 25/62	A-5
*21-1-0	12	July 25/62	A-4
21-1-0	13	Dec. 5/60	B-3
*21-1-0	14	July 25/62	A-5
*21-1-0	15	July 25/62	A-5
21-1-0	16	Dec. 5/60	A-3
*21-1-0	17	July 25/62	A-4
21-1-0	18	May 25/61	A-4
21-1-0	19	May 25/61	A-4
	BLANK		
*21-1-0	201	July 25/62	A-5
*21-1-0	202	Feb. 2/62	A-4
21-1-0	203	May 25/61	A-4
*21-1-0	204	Feb. 2/62	A-4
*21-1-0	205	July 25/62	A-5
*21-1-0	206	Feb. 2/62	A-4
*21-1-0	207	Feb. 2/62	A-4
*21-1-0	208	Feb. 2/62	A-4
*21-1-0	209	Feb. 2/62	A
	BLANK		
21-1-1	1	Dec. 5/60	B-3
21-1-1	2	Dec. 5/60	A-3

*Pages revised, added or deleted by this revision.

LIST OF EFFECTIVE PAGES (CONT)

CHAPTER	PAGE	DATE	CODE
21-1-1	3	Dec. 5/60	B-3
	BLANK		
*21-1-1	201	July 25/62	A-4
21-1-1	202	Dec. 5/60	A-3
*21-1-2	1	July 25/62	A-4
21-1-2	2	May 25/61	A-4
*21-1-2	3	July 25/62	A-4
	BLANK		
*21-1-2	201	July 25/62	A
*21-1-2	202	July 25/62	A
21-1-3	1	Dec. 5/60	A-3
21-1-3	2	May 25/61	A-4
21-1-3	201	Dec. 5/60	A-3
21-1-3	202	May 25/61	A-4
21-1-4	1	Dec. 5/60	A-3
*21-1-4	2	July 25/62	A-5
21-1-4	201	Dec. 5/60	A-3
21-1-4	202	May 25/61	A-4
*21-1-5	1	July 25/62	A-5
*21-1-5	2	July 25/62	A-4
*21-1-5	201	July 25/62	A-4
*21-1-5	202	July 25/62	A
21-1-6	1	Dec. 5/60	A-3
	BLANK		
*21-1-6	201	July 25/62	A-4
*21-1-6	202	July 25/62	A
*21-1-7	1	July 25/62	A-4
*21-1-7	2	July 25/62	A
*21-1-7	201	July 25/62	A-4
*21-1-7	202	July 25/62	A
*21-1-8	1	July 25/62	A-5
21-1-8	2	May 25/61	A-4
*21-1-8	201	July 25/62	A-5
21-1-8	202	May 25/61	A-4
*21-1-8	203	July 25/62	A-5
*21-1-8	204	July 25/62	A-4
*21-1-9	1	July 25/62	A-5
21-1-9	2	May 25/61	A-4
*21-1-9	201	July 25/62	A-4
*21-1-9	202	July 25/62	A-4
*21-1-10	1	July 25/62	A-4
21-1-10	2	May 25/61	A-4
*21-1-10	201	Feb. 2/62	A-4
*21-1-10	202	Feb. 2/62	A-5
*21-1-10	203	Feb. 2/62	A-4
*21-1-10	204	Feb. 2/62	A

CHAPTER	PAGE	DATE	CODE
*21-1-11	1	July 25/62	A-5
21-1-11	2	May 25/61	A-4
21-2-0	1	Dec. 5/60	B-3
21-2-0	2	Dec. 5/60	A-3
21-2-0	3	May 25/61	B-4
	BLANK		
21-2-0	5	May 25/61	B-4
21-2-0	6	May 25/61	B-4
*21-2-0	7	July 25/62	A-5
	BLANK		
*21-2-0	101	Feb. 2/62	A-2
*21-2-0	102	Feb. 2/62	A
21-2-0	201	May 25/61	A-4
21-2-0	202	May 25/61	A-4
*21-2-0	203	Feb. 2/62	A-5
*21-2-0	204	Feb. 2/62	A-5
*21-2-0	205	July 5/61	A-5
*21-2-0	206	Feb. 2/62	A-6
*21-2-0	207	Feb. 2/62	A
*21-2-0	208	Feb. 2/62	A
21-2-1	1	Dec. 5/60	A-3
21-2-1	2	May 25/61	A-4
21-2-1	3	Basic	A
21-2-1	4	Dec. 5/60	A-3
*21-2-1	201	July 25/62	B-4
21-2-1	202	Dec. 5/60	B-3
*21-2-1	203	July 25/62	B-5
	BLANK		
21-2-2	1	Dec. 5/60	A-3
*21-2-2	2	July 25/62	A-4
21-2-2	3	May 25/61	A-4
21-2-2	4	Dec. 5/60	A-3
21-2-2	5	Dec. 5/60	A-3
21-2-2	6	Dec. 5/60	A-3
21-2-2	201	Dec. 5/60	A-3
21-2-2	202	Basic	A
21-2-2	203	Dec. 5/60	A-3
21-2-2	204	May 25/61	A-4
*21-2-3	1	July 25/62	A-5
*21-2-3	2	July 25/62	A-6
*21-2-3	201	July 25/62	A-4
*21-2-3	202	July 25/62	A-5
*21-2-3	203	July 25/62	A-5
*21-2-3	204	July 25/62	A-6
21-3-0	1	Dec. 5/60	A-3
21-3-0	2	Dec. 5/60	B-3

*Pages revised, added or deleted by this revision.

LIST OF EFFECTIVE PAGES (CONT)

CHAPTER	PAGE	DATE	CODE
21-3-0	3	Dec. 5/60	B-3
21-3-0	4	Dec. 5/60	B-3
21-3-0	5	Dec. 5/60	B-3
21-3-0	6	Dec. 5/60	B-3
21-3-0	7	Dec. 5/60	B-3
21-3-0	8	Dec. 5/60	B-3
21-3-0	9	Dec. 5/60	B-3
21-3-0	10	Dec. 5/60	B-3
21-3-0	11	Dec. 5/60	B-3
21-3-0	12	Dec. 5/60	B-3
21-3-0	13	Dec. 5/60	B-3
21-3-0	14	Dec. 5/60	B-3
21-3-0	101	May 23/60	B-1
21-3-0	102	May 23/60	B-1
21-3-0	103	May 23/60	B-1
	BLANK		
21-3-1	1	Dec. 5/60	B-3
21-3-1	2	May 23/60	B-1
21-3-1	3	Dec. 5/60	B-3
21-3-1	4	May 25/61	B-4
21-3-1	5	May 25/61	B-4
21-3-1	6	May 25/61	B-4
21-3-1	7	May 23/60	B-1
21-3-1	8	Dec. 5/60	B-3
21-3-1	9	May 25/61	B-4
21-3-1	10	Dec. 5/60	B-3
21-3-1	11	May 23/60	B-1
21-3-1	12	Dec. 5/60	B-3
21-3-1	13	Dec. 5/60	B-3
21-3-1	14	Dec. 5/60	B-3
21-3-1	15	May 25/61	B-4
21-3-1	16	Dec. 5/60	B-3
21-3-1	17	May 23/60	B-1
21-3-1	18	Dec. 5/60	B-3
21-3-1	19	May 23/60	B-1
21-3-1	20	Dec. 5/60	B-3
21-3-1	21	Dec. 5/60	B-3
21-3-1	22	Dec. 5/60	B-3
21-3-1	23	Dec. 5/60	B-3
21-3-1	24	May 23/60	B-1
21-3-1	101	May 25/61	B-4
21-3-1	102	May 25/61	B-4
21-3-1	103	May 25/61	B-4
21-3-1	104	May 24/61	B-4
*21-3-1	201	July 25/62	B-4
*21-3-1	202	July 25/62	B-5
*21-3-1	203	July 25/62	B-4
*21-3-1	204	July 25/62	B-4
21-3-1	205	May 25/61	B-4
21-3-1	206	May 25/61	B-4
21-3-1	207	Dec. 5/60	B-3
*21-3-1	208	July 25/62	B-4
*21-3-1	209	July 25/62	B-4
*21-3-1	210	July 25/62	B-4
21-3-1	211	Dec. 5/60	B-3
*21-3-1	212	July 25/62	B-4
*21-3-2	1	July 25/62	A-4
21-3-2	2	Dec. 5/60	B-3
21-3-2	201	Dec. 5/60	B-3
21-3-2	202	Dec. 5/60	A-3
21-3-2	203	Dec. 5/60	A-3
21-3-2	204	Dec. 5/60	B-3
*21-3-2	205	July 25/62	B
*21-3-2	206	July 25/62	B
*21-3-2	207	July 25/62	B
	BLANK		
21-3-3	1	May 25/61	B-4
21-3-3	2	May 25/61	A-4
*21-3-3	201	July 25/62	A-5
*21-3-3	202	July 25/62	A-5
*21-3-3	203	July 25/62	A-5
21-3-3	204	May 25/61	A-4
21-3-4	1	Dec. 5/60	A-3
21-3-4	2	May 23/60	B-1
21-3-4	201	Dec. 5/60	B-3
21-3-4	202	Dec. 5/60	B-3
*21-3-4	203	July 25/62	A-4
21-3-4	204	May 25/61	A-4
21-3-5	201	Dec. 5/60	A-3
	BLANK		
*21-3-6	1	Feb. 2/62	A-4
21-3-6	2	May 25/61	A-4
21-3-6	201	Dec. 5/60	A-3
21-3-6	202	Dec. 5/60	A-3
21-3-6	203	May 25/61	A-4
21-3-6	204	Dec. 5/60	A-3
21-3-7	1	Dec. 5/60	B-3
21-3-7	2	May 23/60	B-1
21-3-7	3	Dec. 5/60	B-3
	BLANK		
21-3-7	201	Dec. 5/60	A-3
21-3-7	202	Dec. 5/60	A-3

*Pages revised, added or deleted by this revision.

LIST OF EFFECTIVE PAGES (CONT)

CHAPTER	PAGE	DATE	CODE
*21-3-7	203	July 25/62	A-4
21-3-7	204	May 23/60	B-1
21-3-8	201	Dec. 5/60	B-3
21-3-8	202	Dec. 5/60	A-3
*21-3-9	1	July 25/62	A-5
21-3-9	2	May 25/61	B-4
21-3-9	201	Dec. 5/60	A-3
	BLANK		
21-3-10	1	Dec. 5/60	B-3
21-3-10	2	May 23/60	B-1
21-3-10	201	Dec. 5/60	B-3
21-3-10	202	May 25/61	B-4
21-3-10	203	Dec. 5/60	B-3
21-3-10	204	Dec. 5/60	B-3
21-3-11	1	May 25/61	B-4
21-3-11	2	Dec. 5/60	B-3
21-3-11	201	Dec. 5/60	B-3
	BLANK		
21-3-12	1	Dec. 5/60	B-3
21-3-12	2	May 23/60	B-1
*21-3-12	201	July 25/62	A-4
21-3-12	202	May 25/61	B-4
*21-3-12	203	July 25/62	A-4
	BLANK		
21-3-13	1	Dec. 5/60	B-3
21-3-13	2	Dec. 5/60	B-3
21-3-13	201	Dec. 5/60	B-3
21-3-13	202	Dec. 5/60	B-3
21-3-13	203	Dec. 5/60	B-3
21-3-13	204	Dec. 5/60	B-3
21-3-13	205	Dec. 5/60	B-3
21-3-13	206	Dec. 5/60	B-3
21-3-14	1.	Basic	A
21-3-14	2	Dec. 5/60	B-3
21-3-14	201	Basic	A
21-3-14	202	Dec. 5/60	B-3
*21-3-14	203	July 25/62	A-4
	BLANK		
21-3-15	1	May 23/60	B-1
	BLANK		
21-3-15	201	May 23/60	B-1
	BLANK		
*21-3-16	1	Feb. 2/62	A-4
	BLANK		
*21-3-16	201	July 25/62	A-4
*21-3-16	202	July 25/62	A-4
*21-3-16	203	July 25/62	A-4
	BLANK		
21-3-17	1	Dec. 5/60	B-3
	BLANK		
21-3-17	201	Dec. 5/60	A-3
	BLANK		
21-4-0	1	Dec. 5/60	B-3
21-4-0	2	Dec. 5/60	B-3
	BLANK		
21-4-0	4	May 25/61	B-4
21-4-0	5	May 25/61	B-4
	BLANK		
	BLANK		
21-4-0	8	May 25/61	B-4
21-4-0	9	May 25/61	B-4
	BLANK		
	BLANK		
21-4-0	12	May 25/61	B-4
21-4-0	13	May 25/61	B-4
	BLANK		
	BLANK		
21-4-0	16	May 25/61	B-4
21-4-0	17	May 25/61	B-4
	BLANK		
	BLANK		
21-4-0	20	May 25/61	B-4
21-4-0	21	May 25/61	B-4
	BLANK		
21-4-0	23	Dec. 5/60	B-3
21-4-0	24	Dec. 5/60	B-3
21-4-0	25	May 25/61	B-4
21-4-0	26	Dec. 5/60	B-3
21-4-0	27	Dec. 5/60	B-3
21-4-0	28	Dec. 5/60	B-3
21-4-0	29	Dec. 5/60	B-3
21-4-0	30	Dec. 5/60	B-3
21-4-0	31	Dec. 5/60	B-3
21-4-0	32	Dec. 5/60	B-3
21-4-0	33	May 25/61	B-4
21-4-0	34	Dec. 5/60	B-3
21-4-0	35	May 25/61	B-4
21-4-0	36	Dec. 5/60	B-3
21-4-0	37	May 25/61	B-4
21-4-0	38	Dec. 5/60	B-3
21-4-1	1	Dec. 5/60	A-3
21-4-1	2	May 25/61	B-4

*Pages revised, added or deleted by this revision.

LIST OF EFFECTIVE PAGES (CONT)

CHAPTER	PAGE	DATE	CODE
21-4-1	201	Dec. 5/60	B-3
21-4-1	202	May 25/61	B-4
21-4-1	203 BLANK	Dec. 5/60	A-3
21-4-2	1	Dec. 5/60	B-3
21-4-2	2	May 23/60	B-1
21-4-2	201	Dec. 5/60	A-3
*21-4-2	202	July 25/62	A-4
21-4-2	203 BLANK	Dec. 5/60	A-3
21-4-3	1	May 25/61	B-4
21-4-3	2	May 25/61	B-4
21-4-3	201	Dec. 5/60	B-3
21-4-3	202	May 25/61	B-4
21-4-3	203 BLANK	Dec. 5/60	B-3
21-4-4	1	Dec. 5/60	A-3
21-4-4	2	Dec. 5/60	A-3
21-4-4	201	Dec. 5/60	B-3
21-4-4	202	May 25/61	B-4
21-4-4	203 BLANK	Dec. 5/60	A-3
21-4-5	1 BLANK	Dec. 5/60	A-3
21-4-5	201	Dec. 5/60	A-3
21-4-5	202	Dec. 5/60	A-3
21-4-5	203 BLANK	Dec. 5/60	A-3
*21-4-6	1	July 25/62	A-4
21-4-6	2	Dec. 5/60	B-3
21-4-6	201	Dec. 5/60	A-3
21-4-6	202	Dec. 5/60	A-3
21-4-6	203 BLANK	Dec. 5/60	A-3
21-4-7	1	May 25/61	A-4
21-4-7	2	May 25/61	B-4
*21-4-7	201	Feb. 2/62	A-5
21-4-7	202	May 25/61	A-4
21-4-7	203 BLANK	Dec. 5/60	A-3
21-4-8	1	Dec. 5/60	B-3
21-4-8	2	Dec. 5/60	B-3
21-4-8	201	Dec. 5/60	B-3
21-4-8	202	May 25/61	B-4
21-4-8	203 BLANK	May 25/61	B-4

CHAPTER	PAGE	DATE	CODE
21-4-9	1	Dec. 5/60	B-3
21-4-9	2	Dec. 5/60	B-3
21-4-9	3	Dec. 5/60	B-3
21-4-9	4	Dec. 5/60	B-3
21-4-9	201	Dec. 5/60	B-3
21-4-9	202	May 23/60	B-1
21-4-9	203	May 25/61	B-4
21-4-9	204	Dec. 5/60	B-3
21-4-9	205	Dec. 5/60	B-3
21-4-9	206	Dec. 5/60	B-3
21-4-9	207 BLANK	Dec. 5/60	B-3
21-4-10	1 BLANK	May 25/61	B-4
*21-5-0	1	July 25/62	A-4
21-5-0	2	Dec. 5/60	B-3
*21-5-0	3 BLANK	July 25/62	A-6
21-5-0	101 BLANK	Basic	A
21-5-1	1	Basic	A
21-5-1	2	May 25/61	A-4
21-5-1	3 BLANK	Basic	A
*21-5-1	201	July 25/62	A-4
21-5-1	202	Dec. 5/60	A-3
*21-5-1	203	July 25/62	A-4
21-5-1	204	Dec. 5/60	A-3
21-6-0	1	Dec. 5/60	B-3
21-6-0	2	Dec. 5/60	B-3
21-6-0	101	Dec. 5/60	B-3
21-6-0	102	Dec. 5/60	B-3
21-7-0	1	Dec. 5/60	B-3
21-7-0	2	Dec. 5/60	B-3
*21-8-0	1	Feb. 2/62	A-4
21-8-0	2	Dec. 5/60	A-3
21-8-0	3 BLANK	Dec. 5/60	A-3
*21-8-1	1	Feb. 2/62	A-4
*21-8-1	2	Feb. 2/62	A-4
*21-8-1	201	Feb. 2/62	A
*21-8-1	202	Feb. 2/62	A
*21-8-1	203 BLANK	Feb. 2/62	A
*21-8-2	1	Feb. 2/62	A-4
21-8-2	2	Dec. 5/60	A-3

*Pages revised, added or deleted by this revision.

LIST OF EFFECTIVE PAGES (CONT)

CHAPTER	PAGE	DATE	CODE
21-8-2	3	Dec. 5/60	A-3
	BLANK		
*21-8-2	201	Feb. 2/62	A
	BLANK		
*21-8-3	1	Feb. 2/62	A-4
*21-8-3	2	Feb. 2/62	A-4
*21-8-3	3	Feb. 2/62	A-4
	BLANK		
*21-8-3	201	Feb. 2/62	A
*21-8-3	202	Feb. 2/62	A
21-9-0	1	Dec. 5/60	A-3
21-9-0	2	Dec. 5/60	A-3
*21-9-0	3	July 25/62	A-4
21-9-0	4	May 25/61	A-4
21-9-0	101	Dec. 5/60	A-3
21-9-0	102	Dec. 5/60	A-3
21-9-1	1	Dec. 5/60	A-3
21-9-1	2	Dec. 5/60	A-3
21-9-1	201	Dec. 5/60	A-3
21-9-1	202	May 25/61	A-4
21-9-1	203	May 25/61	A-4
	BLANK		
21-9-2	1	Dec. 5/60	A-3
	BLANK		
21-9-2	201	Dec. 5/60	A-3
21-9-2	202	Dec. 5/60	A-3
21-9-3	1	May 25/61	A-4
	BLANK		
21-9-4	1	May 25/61	A-4
21-9-4	2	Dec. 5/60	A-3
*21-9-4	3	DELETED	

*Pages revised, added or deleted by this revision.

Chapter 21
AIR CONDITIONING

TABLE OF CONTENTS

TABLE OF CONTENTS (CONT)

TABLE OF CONTENTS (CONT)

TABLE OF CONTENTS (CONT)

TABLE OF CONTENTS (CONT)

TABLE OF CONTENTS (CONT)

TABLE OF CONTENTS (CONT)

TABLE OF CONTENTS (CONT)

TABLE OF CONTENTS (CONT)

TABLE OF CONTENTS (CONT)

TABLE OF CONTENTS (CONT)

AIR CONDITIONING AND PRESSURIZATION - DESCRIPTION AND OPERATION

1. General

All occupied compartments of the airplane can be maintained at a sea-level cabin altitude up to an airplane altitude of 20,500 feet, and an 8000-foot cabin altitude up to an airplane altitude of 41,000 feet. The capabilities of the airplane's pressurization system are shown on Figure 1. The air conditioning system supplies circulating fresh air, heated or cooled as conditions require, either on the ground or during flight. Under normal conditions a complete change of air is provided in the cabin every 2-1/2 minutes and in the flight compartment every minute. The air conditioning system is shown on Figure 2.

Presetting of the rate of change of the cabin pressure controller permits rapid changes in flight altitude with a minimum rate of change of cabin altitude. Two cabin pressure regulator and outflow valves are provided to automatically limit the pressure differential to a predetermined value. Should either valve malfunction, the other valve will be capable of maintaining a normal cabin pressure schedule at the normal maximum rate of flow delivered by the pressure source. In the event of a malfunctioning of the automatic features of both cabin pressure regulator outflow valves, both valves can be actuated manually by control switches on the flight engineer's control panel to maintain the desired cabin pressure. The air conditioning system consists essentially of two air conditioning systems that are connected in parallel, but function independently of each other. Each of the systems have separate controls for either automatic or manual operation. One system primarily supplies the flight compartment and the other primarily the cabin. In the discussion of the air conditioning system that follows, a distinction will be made, where possible, between pressurization and air conditioning. Since the airflow required for the flight compartment is less than for the cabin, the excess conditioned air of the flight compartment subsystem is supplied to the cabin. Each air conditioning subsystem is of sufficient capacity to supplement the other should one of them malfunction. Heating and cooling of the baggage compartments and the electrical and electronic equipment is also provided by the air conditioning subsystem.

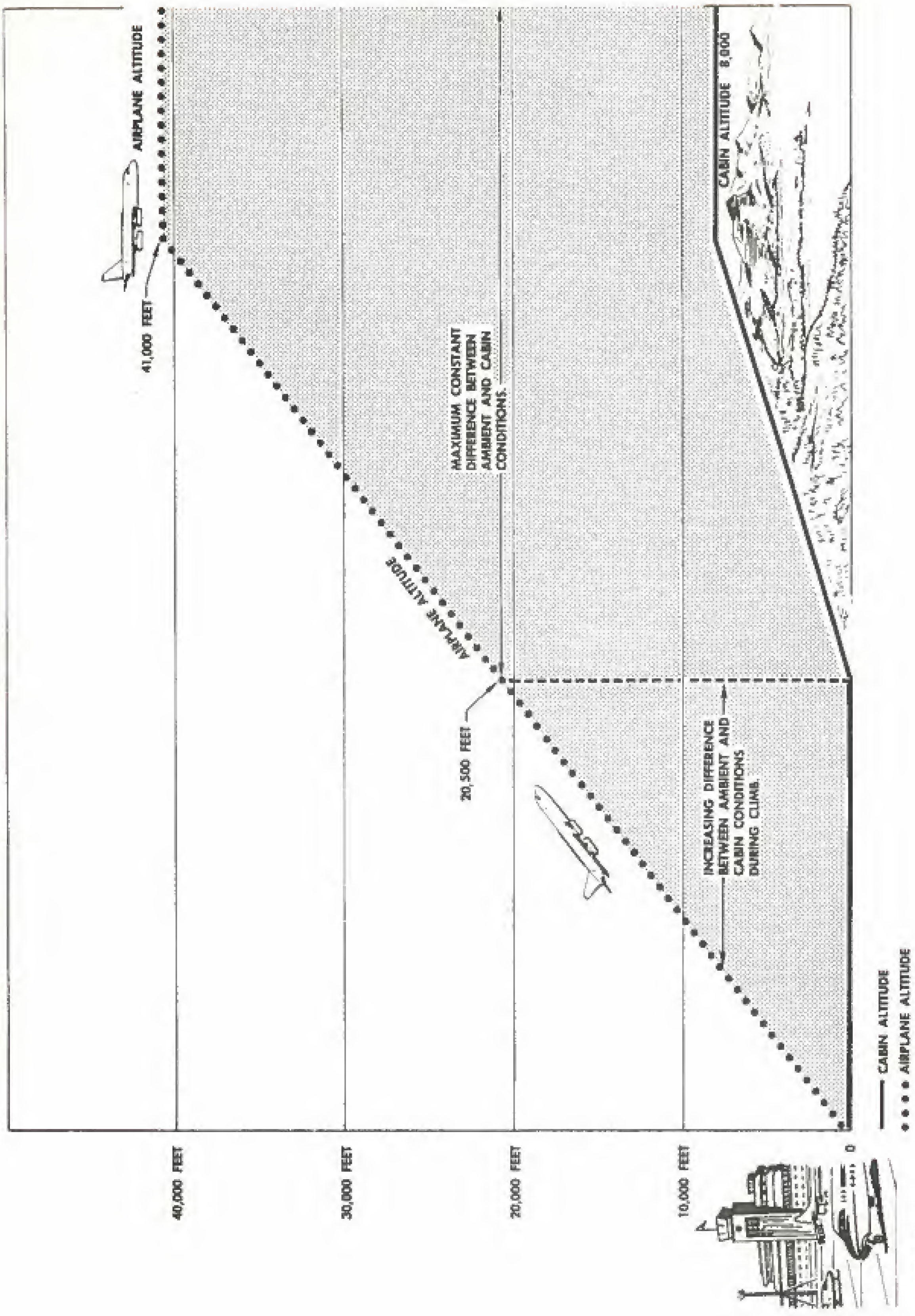
2. Major Components

The major components in each air conditioning and pressurization system include the following:

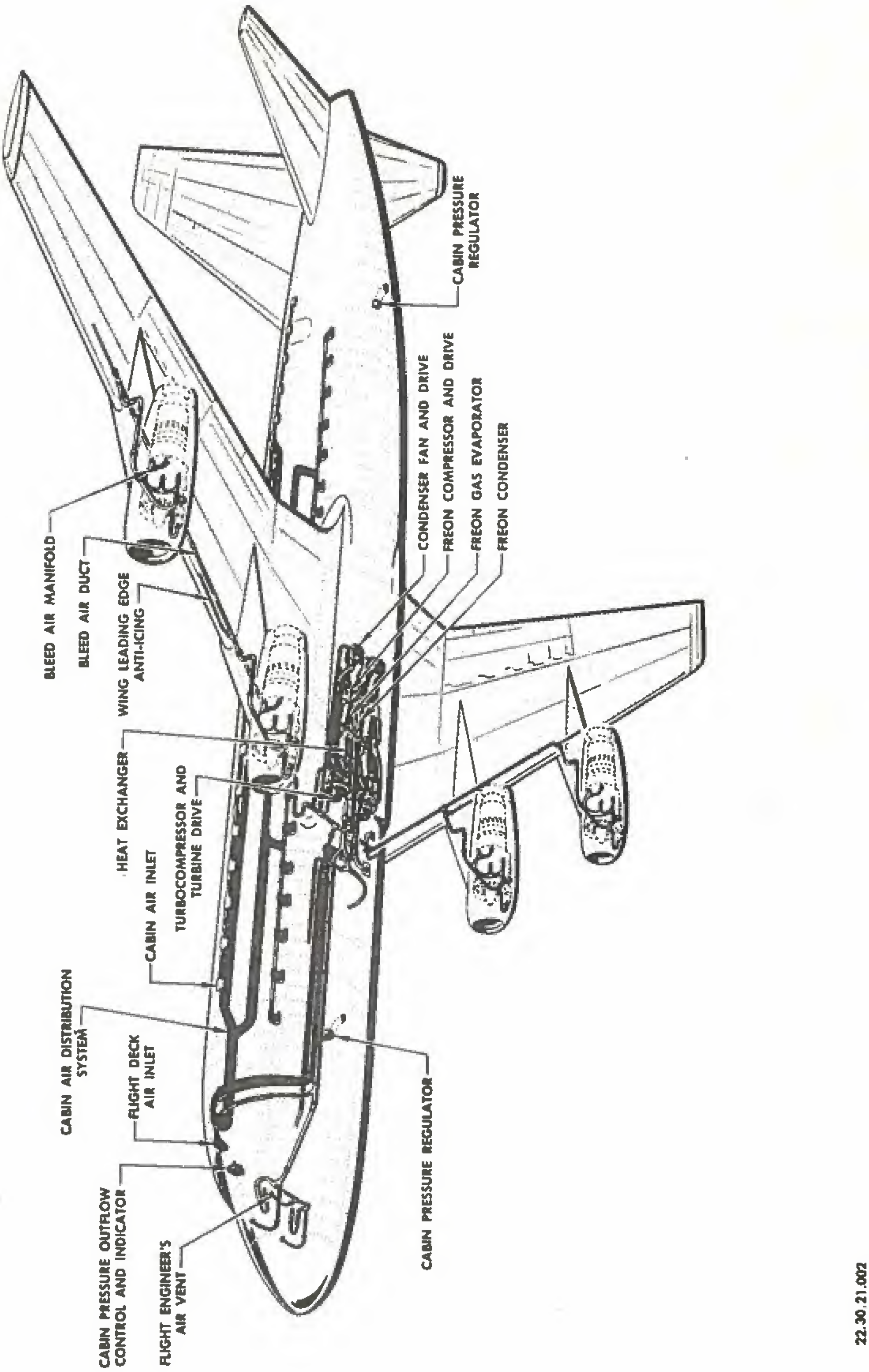
A. The turbocompressor unit which provides pressurized and heated air.

B. The air-to-air heat exchanger which furnishes primary cooling of pressurized air in flight.

C. The Freon subsystem which provides secondary cooling.



Pressurization Capabilities
Figure 1



Air Conditioning and Pressurization System
Figure 2

D. The temperature control subsystem which senses cabin air temperature and provides automatic control of components within the system so that the air temperature will be maintained at a selected level.

E. The electrical heater which provides heating of the cabin air during ground operation.

F. The pressurization control subsystem.

The components of the subsystems are electrically tied together so that normal automatic operation is maintained. A series of switches on the flight engineer's control panel provides automatic or manual control.

3. System Operation - General

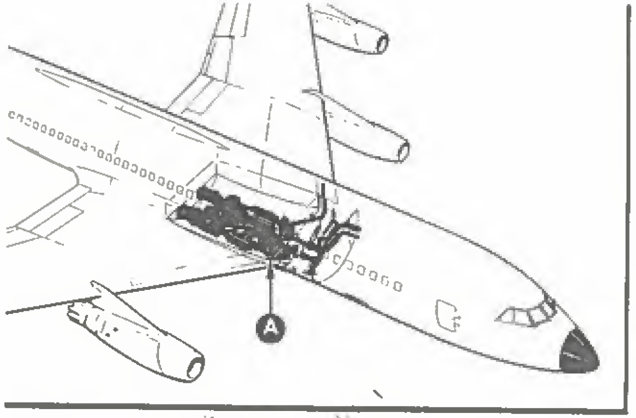
A. Engine Bleed Air.

Bleed air is manifolded from the 17th stage of each of the four turbojet engines into a single bleed air supply line or manifold located in the wing leading edge. This bleed air is used to drive the turbocompressors, supply emergency pressurization, anti-ice the wing leading edges and engine air inlet areas, and provide a source of air for the windshield rain clearing system. For further information on the bleed air system refer to Chapter 36, PNEUMATICS. The bleed air used in the air conditioning and pressurization system is tapped off the single bleed air supply line and is routed to the turbine sections of the two turbocompressors (see Figure 3) and is then discharged overboard.

The compressor section of the turbocompressor draws in, compresses and heats ram air. The heated air is then routed through the air-to-air heat exchanger for primary cooling and through the Freon evaporator for secondary cooling. The cooled and compressed air is then discharged into the flight compratment and cabin by their respective systems to air condition and pressurize these areas.

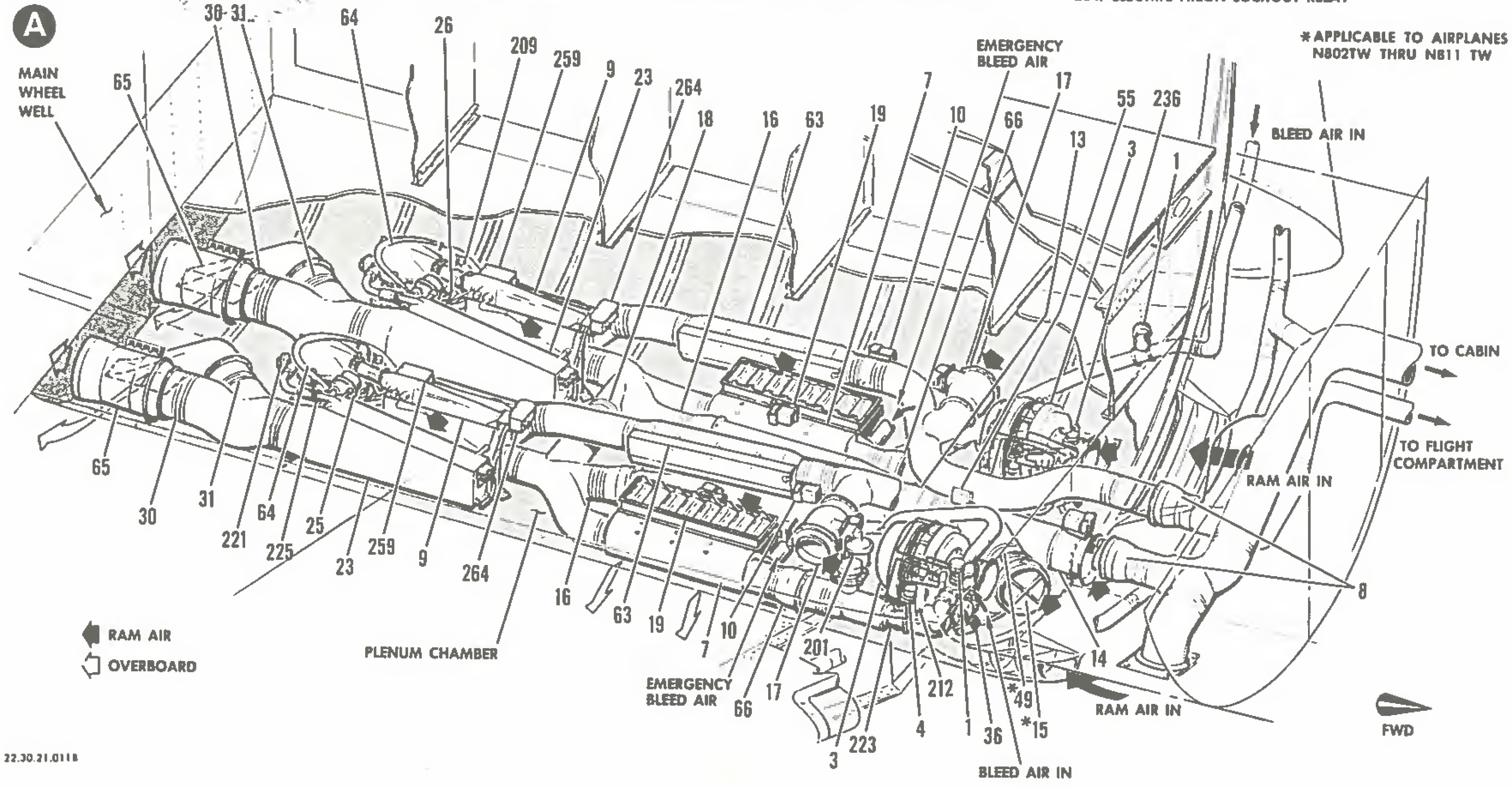
B. Controls.

Automatic or manually operated temperature controls regulate the temperature of the air discharged into the cabin and flight compartment. When more heat is required, these controls open valves that recirculate the compressed ram air back through the turbocompressor for additional heating. The temperature controls also regulate the amount of heat dissipated at the air-to-air heat exchanger and Freon evaporator. When more cooling is required, the compressed air is routed directly to the primary and secondary cooling systems without being recirculated through the compressor. Both the air-to-air heat exchanger and Freon evaporator can be regulated from essentially no cooling to full cooling, dependent upon the cooling requirements.



1. TURBOCOMPRESSOR SHUTOFF VALVE
3. TURBOCOMPRESSOR
4. TURBOCOMPRESSOR FLOW CONTROL
7. HEAT EXCHANGER
8. CONDITIONED AIR CHECK VALVE
9. FREON EVAPORATOR
10. CONDITIONED AIR EMERGENCY SHUTOFF VALVE
13. RECIRCULATION FAN
14. RECIRCULATION CONTROL VALVE
*15. FRESH AIR CHECK VALVE
16. RECIRCULATION AIR CHECK VALVE
17. RAM AIR SHUTOFF VALVE
18. CROSSOVER SHUTOFF VALVE
19. HEAT EXCHANGER COOLING AIR MODULATING VALVE
23. FREON CONDENSER
24. FREON EXPANSION VALVE (NOT SHOWN)
25. BACK PRESSURE REGULATOR VALVE
26. MOTOR COOLING EXPANSION VALVE
30. CONDENSER GROUND COOLING AIR SHUTOFF VALVE
31. CONDENSER COOLING AIR MODULATING VALVE
36. HEAT CONTROL MODULATING VALVE
*49. FRESH AIR CONTROL VALVE
55. AIR FLOW SENSOR AND TRANSMITTER
63. ELECTRIC HEATER
64. FREON COMPRESSOR
65. CONDENSER FAN
66. TURBOCOMPRESSOR CHECK VALVE
69. FREON COMPRESSOR SURGE CONTROL VALVE (NOT SHOWN)
201. TURBOCOMPRESSOR SURGE VALVE
203. FREON DRIER AND STRAINER (NOT SHOWN)
204. FREON COMPRESSOR SURGE VALVE (NOT SHOWN)
209. CONDENSER TEMPERATURE CONTROL
212. PRESSURE LIMITER CONTROL
221. FREON COMPRESSOR SURGE CONTROL
223. VENTURI DUCT
225. BELLOWS CONTROL
236. OVERSPEED CONTROL
259. ELECTRONIC BACK PRESSURE CONTROL
264. ELECTRIC FREON LOCKOUT RELAY

*APPLICABLE TO AIRPLANES N802TW THRU N811 TW



Air Conditioning and Pressurization Package
Figure 3

C. Air Recirculation.

A recirculation subsystem provides a means of ventilating and cooling the airplane compartments on the ground. This system is controlled by a switch on the flight engineer's control panel, and when turned on, the system draws air from the cabin and/or ram air plenum chamber. This air is ducted back into the air conditioning subsystem downstream of the air-to-air heat exchanger where it is cooled or heated depending on the demands of the cabin. The Freon subsystem cools and dehumidifies the recirculated air and an electrical heater provides supplementary heating when required. Although normally used only for ground operation, the recirculation portion of the subsystem can be utilized in flight should one of the turbocompressors malfunction. By utilizing recirculation with the remaining operating turbocompressor, normal circulation through the cabin and flight compartment can be maintained. The electrical heater can only be used for ground operation; it is inoperative in the air.

D. Emergency Pressurization.

Engine bleed air may be used for emergency pressurization of the cabin and flight compartment in the event both turbocompressors fail. Bleed air is ducted into the air conditioning subsystem downstream of the turbocompressor where it is cooled by the air-to-air heat exchanger and the Freon evaporator before being discharged into the cabin and flight compartments.

E. Ram Air.

A ram air shutoff valve, downstream of the Freon evaporator, provides a means of routing fresh air to the cabin and flight compartments. The ram air shutoff valve is manually controlled by a toggle switch on the flight engineer's panel. Regardless of control switch operation, the valve will open only when ram air pressure exceeds cabin pressure. Thus, when the airplane is pressurized, the pressurization system provides a flow of fresh air. If the normal or emergency pressurization systems are not being used, the ram air shutoff valve can be opened to provide fresh air.

F. External Air Conditioner.

The cabin and flight compartment can be heated or cooled after engine shutdown by connecting an external air conditioner to the air conditioning system's ground connection. This externally heated or cooled air is ducted directly to the cabin and flight compartment and bypasses the air conditioning subsystem.

G. Ground Cart Operation.

Compartment heating when the engines are shut down can be accomplished by means of a ground pressure cart to simulate engine bleed air. Freon system operation for compartment cooling can also be accomplished by connecting an external source of electrical power to the airplane.

AIR CONDITIONING AND PRESSURIZATION - TROUBLESHOOTING

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION
1. IN AUTOMATIC OPERATION CABIN TEMPERATURES RISE ABOVE SELECTED SETTING (No indication of malfunction on flight engineer's control panel)	
A. Faulty operation of items which are used in automatic operation.	Manually operate temperature control system for maximum cooling. If adequate cooling is available when in manual control, check items which operate only during automatic operation. Using procedure as shown with GS-1278 check for correct operation of the heat exchanger cool air modulating valve, the heat control modulating valve and the electronic temperature controller. Remove and replace any malfunctioning unit.
B. Malfunctioning sequencing device.	Manually operate the temperature controller system for maximum cooling. Use GS-1278 to determine if sequencing device is at maximum cooling position as directed by the electronic temperature controller. Check the operation of the sequencing device through all quadrants of operation using GS-1278. If the malfunction appears in the sequencing device, remove and replace unit. If the malfunction does not appear in the sequencing device check out the electronic temperature controller with GS-1278, remove and replace if faulty. If the units are in the maximum cooling position but the preset cooling temperature cannot be maintained, check the level of Freon at the Freon liquid level gauges. NOTE: If during this check the indicated liquid level drops to zero and does not immediately return to the stabilized level, shut off the system and recharge the Freon system.
C. Freon compressor of one air conditioning system does not operate.	Check the operation of the FREON FAIL warning light. If defective replace bulb or repair electrical circuitry as required. If the warning light is "on", or if visual check indicates lockout relay has tripped, check that compressor

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION
1. IN AUTOMATIC OPERATION CABIN TEMPERATURES RISE ABOVE SELECTED SETTING (No indication of malfunction on flight engineer's control panel) (CONT)	
	overpressure discharge switch, the overheat switch and the compressor discharge overtemp switch are open. If open press reset switch; the Freon compressor should now be able to be started.
D. No voltage to Freon Compressor motor, open current limiters.	Check the three 70-amp current limiters for indication of open circuit. If all three are open check each power lead and motor winding for a short to ground. If only two limiters are open, check for open airplane wiring or open wiring within compressor motor. Repair as needed if open motor winding, remove and replace Freon package. If limiters open immediately upon replacing, the malfunction is a high potential short within the compressor motor, remove and replace Freon package.
E. No voltage to Freon compressor, compressor motor relay open.	Check that Freon compressor motor relay is closed. If open, check that back pressure regulating valve is closed. If open use GS-1278 to check for malfunctioning back pressure regulating valve, and back pressure valve control. If back pressure control is bad, remove and replace. If back pressure regulating valve is malfunctioning, remove and replace Freon package.
	Check for 28-volt dc between compressor motor relay and ground. If not present, remove the input plug from the lockout relay and measure between A and ground for 28-volt. If no voltage remove the plug from the sequencing device and measure between N and ground for 28-volt. If no voltage present run continuity check back to the 28-volt dc source through Freon compressor ON-OFF and Freon compressor FLT DK OFF-BOTH ON-CABIN OFF control switch; repair as required.

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION
1. IN AUTOMATIC OPERATION CABIN TEMPERATURES RISE ABOVE SELECTED SETTING (No indication of malfunction on flight engineer's control panel) (CONT)	
F. No voltage to Freon Compressor, lockout relay malfunction.	Remove input plug from the lockout relay, measure between pin A and ground for 28-volt dc. If present measure between terminal L and ground for continuity. If no continuity, trouble shoot the airplane wiring through the time delay thermister.
2. CABIN TEMPERATURE FALLS BELOW SELECTED SETTING (No indication of malfunction on flight engineer's panel.)	
A. Faulty operation of items which operate only in automatic control.	Manually operate temperature control system for maximum heating. Check the operation of the sequencing device and the electronic temperature controller using GS-1278 for correct operation and position. If either unit does not operate correctly, remove and replace. Check those items which are used only during flight (heat exchanger cooling air modulating valve and the heat control modulating valve). Use GS-1278 to check valves. Replace any valve which indicates a malfunction.
B. Faulty operation of the temperature selector and thermal resistor bridge.	When operated manually and heat is available, check operation of the temperature selector. When measured at the disconnect plug of the electronic temperature controller (pin 4 to 6), the temperature selector should show a resistance of not more than 100-ohms (full hot position) to no more than 9000-ohms (full cold position). While reading ohmmeter rotate temperature selector from HOT to COLD. If not within this range, remove and replace the temperature selector. Check the resistance of temperature pickups. Measure between pins of the electronic temperature controller plug for: duct temp pickup, pins 2 to 5; cabin or flight deck pickup, pins 4 to 1. The resistance should approximate the following:

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION
2. CABIN TEMPERATURE FALLS BELOW SELECTED SETTING (No indication of malfunction on flight engineer's panel.) (CONT)	
	AIR TEMP / RESISTANCE 90° — 5.5K to 10K 72° — 8K to 15K 54° — 15K to 30K NOTE: These readings are also the same for the CMTC thermister. NOTE: For a quick isolation of a defective unit, substitute a unit known to be good.
C. Malfunction within the sequencing device.	Using the GS-1278, check the operation of the cams in sequencing device. Check this unit from one extreme to the other, noting carefully voltage and time as the cams traverse from full hot to full cold. Refer to Section 21-4-0 for correct schedule. If malfunctioning unit is found, remove and replace.
D. Malfunction in units which operate only during ground operation.	Schedule full hot with the temperature selector. Note that the recirculation fan starts and that heated air should be available at the cabin and/or flight deck conditioned air outlets. There should be 200-volts ac line to line at each element of the heaters. If the correct voltage is not available, remove plug from sequencing device and check continuity from terminal T to terminals L, S, E, K, Q, and X of the sequencing device. If open remove and replace the sequencing device. If OK, remove the limit switch plug from the electric heaters. Measure between terminal A and ground for 28-volts dc.
E. Malfunction in the limit switch control circuit.	Remove the limit switch plug from the electric heaters. Check continuity between terminals A and B. If open remove and replace the electric heaters. If OK, trace the 28-volt dc from terminal T of the sequencing device to the landing gear ground safety switch through the FLT DK OFF-BOTH ON-CABIN OFF switch

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION

2. CABIN TEMPERATURE FALLS BELOW SELECTED SETTING (No indication of malfunction on flight engineer's panel.) (CONT)

	to the GRND HEATER CB and to the 28-volt dc ess bus.
F. Malfunction in the electric heaters.	Remove power from the air conditioning system and check continuity of all heater elements. If one or more elements are open, replace the electric heater. If OK, check position of the air control valves. Recirculation control valve should be fully opened and the fresh air valve should be fully closed. Use GS-1278 to determine correct operation of these valves. Remove and replace any valve found to be malfunctioning.
G. Inadequate heating from turbocompressor package.	Schedule maximum heating from turbocompressor package using test set GS-1278. Disconnect heat recirculation temperature limiter control servo tube. Cap removed tube. If turbocompressor temperature increases the malfunction is in the heat recirculation temperature limiter control. Remove and replace control. If the discharge temperature remains constant use test set GS-1278 to monitor operation of the heat control modulating valve. If valve actuator is malfunctioning check circuitry between valve and electronic temperature controller. If circuitry is OK, replace valve; if circuitry is faulty, repair as necessary. If valve actuator if OK, the malfunction is probably within the heat control modulating valve; remove and replace valve.

3. FLIGHT ENGINEER'S CONTROL PANEL INDICATES A MALFUNCTION WITHIN THE FREON PACKAGE (FREON FAIL light ON)

A. Inadequate cooling of condenser.	Check air passage through core. If OK, and inadequate condenser cooling exists only during flight, simulate flight operation and check operation of condenser cool air modulating valve, condenser temperature control, and thermal resistor (CMTC). Replace malfunctioning component. If flight conditions are

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION

3. FLIGHT ENGINEER'S CONTROL PANEL INDICATES A MALFUNCTION WITHIN THE FREON PACKAGE (FREON FAIL light ON) (CONT)

	satisfactory, check that the condenser fan is operating. Check that cool air modulating valve is fully closed. If open, remove power plug and check for 115-volt from terminal D to G and from E to G. If no voltage is found, a defective ground safety relay, open in wiring, or a malfunctioning condenser temperature control exists. Isolate and repair as necessary. If these are operating correctly, the malfunction is in the condenser cool air modulating valve. Remove and replace.
B. Malfunction in the condenser fan. Fan not operating.	Check for 28-volt dc across coil of condenser fan motor relay. If no voltage check reset on fan lockout relay. If control circuit is open, the fan has probably overheated, check for blocked duct. If ducting is obstructed clean as required. If not blocked, remove and replace condenser fan. If the relay is not locked out, check for 28-volt dc from fan motor relay to ground. If voltage is correct, the internal ground through the lockout relay has been broken. Remove and replace the condenser fan. If no voltage exists check wiring through ground safety relay to the 28-volt dc bus.
C. Malfunction in the fan control circuit or in the windings of the condenser from motor.	Check the continuity of the fan motor power relay coil. If open replace relay. If good, check contacts for completion of power circuit; if malfunction is determined, remove and replace. If 115/200-volt ac not available to fan motor relay, check current limiters from the ac essential bus, remove and replace limiters as required. If limiters are OK, remove and replace condenser fan. If less than three limiters are open, check for short in airplane wiring or in the fan motor. Repair or replace as necessary.

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION

4. "AIR FLOW" INDICATOR SHOWS LOSS OF COMPLETE SYSTEM FLOW DURING GROUND OPERATION (Normal flow indicated during flight)

A. Recirculation fan not operating.	Check 115/200-volt ac limiter in power leads from ESS AC BUS to reset lockout relay and to the recirculation fan. If limiters are open check fan and airplane wiring for continuity and shorts. Repair or replace as necessary. Check mechanical operation of fan motor, if defective replace fan.
B. Recirculation fan not operating, 115/200-volt ac available.	Place the RECIRCULATING BLOWER ON-OFF switch in the ON position. Voltage on terminal 5 should read 28-volt dc to ground. Repair or replace switch or wiring as necessary. Make a voltage check on X_1 and X_2 of the recirculation reset lockout relay for 28-volt dc. If no voltage on X_1 repair airplane wiring as necessary. If no voltage on X_2 remove and replace lockout relay. Make a voltage check on terminals A and C to ground of the recirculation fan motor. If 28-volt dc is not found the malfunction is in the thermal overload relay or in the internal wiring of the recirculation fan motor. Remove and replace unit. If the correct voltages are found above and the recirculation fan does not operate, the malfunction is in the mechanical components of the fan motor. Remove and replace fan motor assembly.
C. Recirculation control valve malfunctioning.	Manually position the sequencing device from full cooling to full heating and back to full cooling using the MAN HOT-MAN COLD switch. Determine the position of the sequencing device using test set GS-1278. Observe the operation of the recirculation control valve. This valve should operate to the open position. Use test set GS-1278 for test. Remove and replace valve if malfunctioning.

5. HALF SYSTEM FLOW INDICATED (Air flow indicator shows half system operation with no other malfunction indicated on flight engineer's control panel)

A. Malfunction in air flow sensor system.	Check for operation of airflow sensor by operating recirculation fan and

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION

5. HALF SYSTEM FLOW INDICATED (Air flow indicator shows half system operation with no other malfunction indicated on flight engineer's control panel(CONT)

	checking operation of sensor or indicator. Substitute sensor and indicator known to be good for each unit. Remove and replace defective unit. If still not giving true indication. check airplane wiring, using standard techniques. Remove plug from air flow indicator on flight engineer's control panel, with 28-volts dc POWER OFF, continuity between terminal A to B (cabin) will show resistance, terminal C to D (flt deck) will show resistance, also check from each terminal to ground for possible short.
B. Restriction in air flow within ducts, heat exchanger or check valves.	Check for airflow from turbocompressor package, if no airflow trouble shoot the turbocompressor package. Check for a malfunctioning turbocompressor check valve, or a blocked or broken duct to the heat exchanger. Remove and replace as necessary. Check for a blocked heat exchanger core. Clean as required.
C. Malfunction of the conditioned air emergency shutoff valve or the ram air shutoff valve.	Check operation of conditioned air emergency shutoff valve. Use Test set GS-1278 to check operation of valve. If malfunction is indicated in valve remove and replace valve. If no malfunction indicated in operation, defect may be in wiring. Remove plug from valve, pin A to C (open) should read 115-volts ac with no voltage from pin B to C (close). If the correct voltages are not present, check voltage to AC source through Freon compressor CABIN OFF-BOTH ON-FLT DK switch to circuit breaker on the NO. 2 ESS AC BUS. Repair wiring or replace switch or circuit breaker as required. Check position of the ram air shutoff valve, this should be in the CLOSE position. If open, remove connector to valve, measure between pins B to C for 115-volts ac. If correct, remove and replace valve. If incorrect check continuity from plug to RAM AIR SOURCE switch and to NO. 2 ESS AC BUS. Repair wiring or replace switch or circuit breaker as necessary.

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION
6. AIRFLOW INDICATOR SHOWS HALF SYSTEM OPERATION, RPM AND CONTROL AT ZERO (No other indication on flight engineer's control panel. Turbocompressor will not start when switch is toggled)	
A. Possible malfunction in the solenoid air shutoff valve or associated circuitry.	Remove plug from turbocompressor solenoid air shutoff valve: Measure from A to C (ground) for 28-volts dc. If continuity shows, replace plug and check overspeed relay for tripped condition. If not tripped, check that reverse thrust relay is deactivated and that 28-volts dc is available from turbocompressor AUTO-OFF-MAN ON switch and from the TURBO COMPR ON circuit breaker. Repair or replace components as necessary.
B. Short in turbocompressor.	Remove the turbocompressor power plug and check for a short from V, U, R or S of this plug. If short exists, the trouble is in the wiring between the plug and the 28 VOLT DC ESS BUS. Replace components or repair wiring as necessary. Check for short from A and B to ground of solenoid air shutoff valve. If none exists the malfunction is in the turbocompressor. Remove plug from the overspeed control on the turbocompressor package. Check for short from V,U,R, and S of the overspeed control to ground. If the short exists, turbocompressor wiring harness or accessories are shorted, remove and replace package. If the short is no longer present, the malfunction is within the overspeed control and the turbocompressor must be replaced. NOTE: If all electrical components of the turbocompressor system are functioning in a normal manner, but the turbocompressor does not operate, the malfunction is within the turbocompressor package pneumatic system.
7. INADEQUATE AIR HEATING FROM TURBOCOMPRESSOR PACKAGE (Compressor discharge temperature constant when heating is scheduled)	
A. Malfunctioning recirculation temperature limiter control,	Disconnect heat recirculation temperature limiter servo tube. Cap removed

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION

7. INADEQUATE AIR HEATING FROM TURBOCOMPRESSOR PACKAGE (Compressor discharge temperature constant when heating is scheduled) (CONT)

recirculation altitude shutoff control, or heat control modulating valve.	tube. With test set GS-1278 schedule inflight heating. If the turbocompressor discharge temperature increases, remove and replace the heat recirculation temperature limiter control. If the temperatur remains constant, reconnect temperature limiter control servo tube. Disconnect recirculation altitude shutoff control servo tube. Cap "tee" fitting to valve servo line. With GS-1278, schedule inflight heating. If the temperature increases, remove and replace recirculation altitude shutoff control. If the turbocompressor discharge temperature remains constant, check the operation of the heat control modulating valve. Use test set GS-1278 to monitor operation of actuator and valve. Visually check position of valve. If the malfunction is in the valve actuator electrical circuits, check continuity of wiring from valve actuator to electronic temperature controller. Repair airplane wiring as necessary. If the unit's electrical operation is normal, remove and replace the heat control modulating valve.

8. TURBOCOMPRESSOR PACKAGE WILL NOT OPERATE (No overspeed indication on flight engineer's panel)

A. Possible overspeed malfunction.	Test bulb and circuit in the overspeed warning system, replace bulb and repair as necessary. If the bulb lights and indicates an overspeed malfunction, refer to Step 10, TURBOCOMPRESSOR OVERSPEED malfunction. If the malfunction is not an overspeed condition, check the operation of the turbocompressor shutoff valve. Disconnect the overspeed vent line from valve port "30" and cap port in the valve. If the turbocompressor shutoff valve remains closed, remove and replace this valve. If the turbocompressor then operates, the malfunction is in the overspeed control, remove and replace turbocompressor package.

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION

9. TURBOCOMPRESSOR OUTPUT LOW (ENGINE BLEED AIR SUPPLY pressure correct and AIRFLOW indicator reading low)

A. Servo pressure malfunction.	Visually check that turbocompressor shutoff valve is fully open. If the valve is not fully open, remove and replace. If turbocompressor shutoff valve is open, measure the pressure to turbocompressor servo inlet. This should be 9.0 psig minimum; if below this value repair or replace airplane servo bleed aid lines as required (refer to Chapter 36, PNEUMATICS). If the servo inlet air pressure is above 9.0 psig measure servo bleed air pressure at the pressure regulator outlet; this pressure shall be 10.5 psig or more. If less, remove and replace pressure regulator. If pressure is correct remove and replace turbocompressor package.
B. Malfunctioning surge valve or surge control.	Manually check turbocompressor surge discharge port. If the surge valve is closed, the malfunction is between the turbocompressor and the outlet to the cabin or flight deck. Repair ducting as required. If the surge valve is open, check for a blocked duct or a restriction in the duct, such as a foreign object or dent. Repair or replace the ducts as necessary. If the ducting is satisfactory, disconnect the servo air line from the pressure regulator outlets and attach a pressure gage. The pressure of the regulator output shall be 10.5 psig or more. If the outlet pressure of the regulator is correct, connect a flexible tube to the outlet of the pressure pressure regulator and to the inlet port of the surge valve. If the surge valve does not close, remove and replace the surge valve. If the surge valve closes and normal turbocompressor discharge flow is resumed, remove and replace the turbocompressor; the malfunction is in the surge control which cannot be replaced in line maintenance.

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION
10. TURBOCOMPRESSOR OVERSPEED	
A. Overspeed cutout actuator malfunction.	Reset overspeed cutout and re-run turbocompressor; observe RPM, flowrate, bearing temperature and overspeed light. RPM and flow rate appear normal but overspeed trips, the malfunction is in the overspeed cutout actuator. Remove and replace turbocompressor. Flow rate and RPM above normal, remove tubing between flow control and pressure regulator valve. Attach a pressure gage to the pressure regulator valve outlet. The pressure shall read between 10.5 and 16 psig when the turbocompressor is operated. If the pressure exceeds 16 psig, remove and replace pressure regulator. If trouble persists check engine bleed air pressure; pressure shall not exceed 42 psig. If pressure is correct and turbocompressor rpm is low, check port "22" on the venturi duct, and port "21" on the piezometer for obstruction. Check sensing tubes and ports for obstructions, clean or replace as necessary. No obstruction in ports or sensing tubes, the malfunction is in the flow control of the bias pressure control. Remove and replace turbocompressor. If the pressures as measured above are correct, and the turbocompressor approaches overspeed, the malfunction is in the nozzle actuator. Remove and replace turbocompressor.
B. Pressure regulator malfunction. Overspeed cutout has not actuated, RPM higher than usual.	Start turbocompressor and observe RPM, flow rate and bearing temperature. Both RPM and air flow indicator are above normal with no malfunction indicated on bearing temperature gage, remove and replace pressure regulator.

AIR CONDITIONING AND PRESSURIZATION SYSTEM - MAINTENANCE PRACTICES

1. Adjustment/Test

A. General.

The following procedure provides a functional check of the turbocompressors, air conditioning packages, recirculation fan, temperature control system and the associated control valves. The procedure does not check the operation of the pressurization control system. The Adjustment/Test procedure for the cabin pressure controller and pressure-regulating outflow valves is covered in 21-2-0, PRESSURIZATION CONTROLS AND INDICATION.

The functional test may be performed either with the engines operating, or by using ground carts to supply electrical and pneumatic power. When using ground carts to supply power, thrust reverse function of the engines must be simulated to accomplish a complete check.

B. Equipment Required.

(1) External source of 115/200-volt, 3-phase, 400 cycle ac electrical power (refer to Chapter 24, ELECTRICAL POWER).

(2) External source of pneumatic power (15-40 psig).

(3) Hair drier or equivalent to simulate an increase in conditioned air temperature.

(4) Shop air or equivalent to simulate a decrease in conditioned air temperature.

C. Preparation.

(1) Ascertain that RECIRC FAN MOTOR LIMITERS are installed in ac power distribution box.

(2) Ascertain that the following limiters have been removed.

(a) COND GND COOL CABIN

(b) FREON COND CABIN

(c) COND GND COOL FLT DECK

(d) FREON COND FLT DECK

(3) Place the following switches on the flight engineer's control panel in the positions indicated.

(a) RECIRCULATING BLOWER switch - OFF

(b) FREON COMPRESSOR ON-OFF switch - OFF

(c) FREON COMPRESSOR FLT DECK OFF-BOTH ON-CABIN OFF switch - BOTH ON

(d) Cabin and flight deck AUTO-OFF-MAN temperature control switch - OFF

(e) Cabin and flight deck turbocompressor ON-OFF switches - OFF

(f) CABIN TEMP CONTROL and FLIGHT DECK TEMP CONTROL selectors - centered

(4) Close the following circuit breakers:

(a) RECIRC FAN CONT

(b) CAB FLT DECK AIR SHUT-OFF

(c) EVAP AIR MANF SHUTOFF VALVE

(d) Cabin and flight deck ELEC TEMP CONTROL

(e) Cabin and flight deck HEATER CONT RELAY

(f) RH and LH LDG GEAR GRD SAFETY SW

(g) Cabin and flight deck COND GND COOL

(5) Test operation of warning lights on air conditioning and pressurization control panel. (Test switch is located on lower right portion of flight engineer's control panel above the oxygen control panel.

(6) Open air conditioning and pressurization compartment access doors.

(7) Ascertain that CABIN HEATER and FLIGHT DECK HEATER circuit breakers in Freon package compartments are open.

(8) Ascertain that the cabin and flight deck condenser cooling air modulating valves are closed. (Valves are located aft of Freon package access doors and forward of condenser fans.)

(9) Connect external source of electrical power to airplane (refer to Chapter 24, ELECTRICAL POWER).

D. Perform Operational Check of Electrical System.

(1) Place FREON COMPRESSOR FLT DECK OFF-BOTH ON-CABIN OFF switch in FLT DECK OFF position and check for the following:

(a) Flight deck conditioned air emergency shutoff valve shall close.

(b) Cabin conditioned air emergency shutoff valve shall remain open.

(c) Crossover shutoff valve shall open.

(2) Place FREON COMPRESSOR FLT DECK OFF-BOTH ON-CABIN OFF switch in CABIN OFF position and check for the following:

(a) Flight deck conditioned air emergency shutoff valve shall open.

(b) Cabin conditioned air emergency shutoff valve shall close.

(c) Crossover shutoff valve shall remain open.

(3) Place FREON COMPRESSOR FLT DECK OFF-BOTH ON-CABIN OFF switch in BOTH ON position and check for the following:

(a) Flight deck conditioned air emergency shutoff valve shall remain open.

(b) Cabin conditioned air emergency shutoff valve shall open.

(c) Crossover shutoff valve shall close.

(4) On airplanes N802TW through N811TW, place RECIRCULATING BLOWER switch in ON position; recirculation fan shall start.

(a) Place cabin AUTO-OFF-MAN temperature control switch in MAN position.

(b) Place and hold cabin MAN HOT-MAN COLD temperature control switch in MAN COLD position (not to exceed 2 minutes) and check for the following:

(1) Cabin fresh air control valve shall close and the recirculation air control valve shall open.

(c) Place and hold cabin MAN HOT-MAN COLD temperature control switch in MAN HOT position (not to exceed 2 minutes) and check for the following:

(1) Cabin fresh air control valve shall open and then close, and the recirculation air control valve shall close and then open.

<u>NOTE</u>: The above valve action shall take approximately 80 seconds.

(d) Place RECIRCULATING BLOWER switch in OFF position; recirculation fan shall stop.

(5) On airplanes N801TW and 812TW through N830TW, place cabin AUTO-OFF-MAN temperature control switch in MAN position.

(a) Place RECIRCULATING BLOWER switch in ON position and check for the following:

(1) Recirculation air control valve shall open.

(2) Recirculation fan shall start.

(b) Place RECIRCULATING BLOWER switch in OFF position and check for the following:

(1) Recirculation air control valve shall close.

(2) Recirculation fan shall stop.

(6) Place cabin AUTO-OFF-MAN temperature control switch in the OFF position.

(7) Place flight deck AUTO-OFF-MAN temperature control switch in MAN position.

(8) Place and hold flight deck MAN HOT-MAN COLD temperature control switch in MAN HOT position for 30 seconds and check for the following:

(a) Flight deck heat exchanger cooling air modulating valve shall close.

(b) Cabin heat exchanger cooling air modulating valve shall be inactive.

(9) Place and hold flight deck MAN HOT-MAN COLD temperature control switch in MAN COLD position for 30 seconds and check for the following:

(a) Flight deck heat exchanger cooling air modulating valve shall open.

(b) Cabin heat exchanger cooling air modulating valve shall be inactive.

(10) Place flight deck AUTO-OFF-MAN temperature control switch in OFF position.

(11) Proceed to ground operational test of system.

E. Air Conditioning System Ground Test.

(1) Install the following limiters:

(a) COND GND COOL CABIN

(b) FREON COND CABIN

(c) CABIN FLT DECK RECIRC FAN MOTOR

(d) COND GND COOL FLT DECK

(e) FREON COND FLT DECK

(2) Close the following additional circuit breakers:

(a) CABIN FREON SYS CONT

(b) FLT DECK FREON SYS CONT

(c) AIR FLOW IND

(3) Rotate CABIN TEMP CONTROL and FLIGHT DECK TEMP CONTROL selectors to center position.

(4) Heat conditioned air discharge temperature sensor with hair drier to above 75° F.

(5) On airplanes N802TW through N811TW, place cabin and flight deck AUTO-OFF-MAN temperature control switches in AUTO position.

(a) Place RECIRCULATING BLOWER switch in ON position and check for the following:

(1) Recirculation fan shall start and deliver air to the cabin and flight deck air distribution systems.

<u>NOTE</u>: COMPRESSOR AIR FLOW indicator shall indicate approximately equal flow for cabin and flight deck.

(6) On airplanes N801TW and N812TW through N830TW, place RECIRCULATING BLOWER switch in ON position and check for the following:

(a) Recirculation fan shall start.

(b) Recirculation air control valve shall open.

<u>NOTE</u>: COMPRESSOR AIR FLOW indicator shall indicate approximately equal flow for cabin and flight deck.

(c) Place cabin and flight deck AUTO-OFF-MAN temperature control switches in AUTO position.

(7) Place FREON COMPRESSOR ON-OFF switch in ON position and check for the following:

(a) Cabin and flight deck Freon packages shall start.

NOTE: Condenser fan shall start before the Freon compressor.

CAUTION: CHECK FREON LIQUID LEVEL GAGES FOR STABLE READINGS IMMEDIATELY AFTER PACKAGES START OPERATING. IF INDICATED LIQUID LEVEL DROPS BELOW 0, AND DOES NOT RISE IMMEDIATELY TO A STABLE LEVEL, SHUT DOWN SYSTEM/S AND SERVICE FREON PACKAGE/S (REFER TO CHAPTER 12, SERVICING).

(b) Ascertain that the cabin and flight deck condenser ground cooling air shutoff valves are fully open by observing position indicator on valves. (Valves are located aft of the Freon package access doors and forward of the condenser fans.)

(c) Ascertain that the cabin and flight deck condenser cooling air modulating valves are fully closed by observing position indicator on valves. (Valves are located aft of the Freon package access doors in duct leading to discharge port in lower surface of fuselage.)

(8) Place cabin and flight deck AUTO-OFF-MAN temperature control switches in MAN position.

(9) Rotate CABIN TEMP CONTROL and FLIGHT DECK TEMP CONTROL selectors (potentiometer) to full hot (extreme clockwise position) position.

(10) Place cabin and flight deck MAN HOT-MAN COLD temperature control switches in MAN COLD position and hold for 30 seconds; cabin and flight deck heaters shall remain off and Freon packages shall continue to operate.

NOTE: On airplanes N802TW through N811TW, the cabin fresh air control valve shall close as the recirculation air control valve opens.

(11) Using shop air or similar source, cool the conditioned air discharge temperature sensors to below 75° F. Close CABIN AND FLIGHT DECK HEATER circuit breakers; the cabin and flight deck heaters shall remain off.

(12) Place cabin and flight deck AUTO-OFF-MAN temperature control switches in AUTO position and check for the following:

(a) Cabin and flight deck Freon packages shall shut down (not to exceed one minute).

(b) Cabin and flight deck heaters shall operate and the cabin and flight deck conditioned air discharge temperature shall increase.

NOTE: On airplanes N802TW through N811TW the cabin recirculation air control valve shall close and then possibly modulate. Also, the cabin fresh air control valve shall open and then possibly modulate.

(13) Open 24 CABIN and FLIGHT DECK HEATER circuit breakers in Freon package compartment.

(14) Place cabin and flight deck AUTO-OFF-MAN temperature control switches in MAN position.

(15) Hold cabin and flight deck MAN HOT-MAN COLD temperature control switches in MAN HOT position for not more than 1 minute and check for the following:

(a) Cabin and flight deck conditioned air temperatures shall not increase.

NOTE: On airplanes N802TW through N811TW the recirculation air control valve shall open fully. Also, the cabin fresh air control valve shall close fully.

(16) Place cabin and flight deck AUTO-OFF-MAN temperature control switches in AUTO position.

(17) Close CABIN and FLIGHT DECK HEATER circuit breakers three at a time at 5 second intervals and check for the following:

(a) On airplanes N802TW through N811TW, the recirculation air control valve shall "creep" toward the closed position and the cabin fresh air control valve shall "creep" toward the open position. When valve movement has been verified, open the CABIN and FLIGHT DECK HEATER circuit breakers.

NOTE: Valve movement indicates the 160°F thermal switch has actuated. Valve movement may not be noticeable until several heater circuit breakers have been closed on each side.

(b) On airplanes N801TW and N812TW through N830TW the Freon packages shall operate. When the Freon packages start operating, open the CABIN and FLIGHT DECK HEATER circuit breakers.

(18) Place cabin and flight deck AUTO-OFF-MAN temperature control switches in MAN position.

(19) Rotate CABIN TEMP CONTROL and FLIGHT DECK TEMP CONTROL selectors (potentiometer) to full cold (counterclockwise) position.

(20) Place cabin and flight deck MAN HOT-MAN COLD temperature control switches in MAN HOT position until the following action occurs:

(a) On airplanes N802TW through N811TW, the recirculation air control valve shall open and the cabin fresh air control valve shall close.

(b) On airplanes N801TW and N812TW through N830TW, the Freon packages will shut down.

(21) Place cabin and flight deck AUTO-OFF-MAN temperature control switches in AUTO position, close CABIN and FLIGHT DECK HEATER circuit breakers and check for the following:

(a) On airplanes N802TW through N811TW the recirculation air control valve shall close and then possibly modulate, and the cabin fresh air control valve shall open and then possibly modulate; then the cabin and flight deck Freon packages shall start.

(b) On airplanes N801TW and N812TW through N830TW the cabin and flight deck Freon packages shall operate.

(22) Place Freon compressor FLT DECK OFF-BOTH ON-CABIN OFF control switch in CABIN OFF position and check for the following:

(a) Cabin Freon package shall shut down.

(b) Flight deck Freon package shall continue to operate.

(23) Place cabin AUTO-OFF-MAN temperature control switch in MAN position and place and hold the cabin MAN HOT-MAN COLD temperature control switch in the MAN HOT position for 2 minutes; the cabin electric heater shall be cool.

(24) Place flight deck AUTO-OFF-MAN temperature control switch in MAN position and place flight deck MAN HOT-MAN COLD temperature control switch in MAN HOT position until flight deck Freon package shuts down, then open the FLIGHT DECK HEATER circuit breakers.

(25) Place RECIRCULATING BLOWER switch in OFF position and check for the following:

(a) On airplanes N801TW and N812TW through N830TW, the cabin air recirculation control valve shall close.

(26) Place Freon compressor FLT DECK OFF-BOTH ON-CABIN OFF switch in BOTH ON position; cabin and flight deck electric heaters shall remain cool.

(27) Place cabin AUTO-OFF-MAN temperature control switch in AUTO position. As soon as the cabin Freon package starts operating, immediately place RECIRCULATING BLOWER switch in ON position and check for the following:

(a) Cabin and flight deck COMPRESSOR AIR FLOW indicator shall indicate approximately equal flow between cabin and flight deck.

NOTE: On airplanes N801TW and N812TW through N830TW, the recirculation air control valve shall open.

(28) Place Freon compressor FLT DECK OFF-BOTH ON-CABIN OFF control switch in FLT DECK OFF position and close the FLIGHT DECK HEATER circuit breakers.

(29) Place flight deck MAN HOT-MAN COLD temperature control switch in MAN HOT position and hold for 2 minutes; flight deck electric heaters shall be cold.

(30) Rotate CABIN TEMP CONTROL and FLIGHT DECK TEMP CONTROL selectors (potentiometer) to approximately the center position.

(31) Place cabin and flight deck AUTO-OFF-MAN temperature control switches in AUTO position.

(32) Place Freon compressor FLT DECK OFF-BOTH ON CABIN OFF control switch in BOTH ON position and allow system to stabilize in this configuration for approximately 1 minute.

(33) Proceed to airborne operational test.

F. Airborne Operational Test of System.

(1) Ascertain that the following valves are closed.

(a) Wing anti-ice shutoff valves.

(b) Engine starter control valves.

(c) Engine bleed air regulator and check valves.

(d) Nose cowl duct lip anti-ice air control valves.

(e) Vortex destroyer control valves.

(f) Windshield rain clearing shutoff valves.

(2) Open IGNITION POWER (4) and IGNITION CONTROL (4) circuit breakers. Place warning tags on open circuit breakers. (Ignition system shall be de-energized during entire airborne test procedure.)

(3) Position the following switches (on flight engineer's control panel) in the positions indicated:

(a) RECIRCULATING BLOWER switch - OFF

(b) FREON COMPRESSOR ON-OFF switch - OFF

(c) FLT DECK OFF-BOTH ON-CABIN OFF switch - BOTH ON

(d) Cabin and flight deck AUTO-OFF-MAN temperature control switch - OFF

(e) Cabin and flight deck turbocompressor AUTO-OFF-MAN ON switch - OFF

(f) FLIGHT DECK TEMP CONTROL and CABIN TEMP CONTROL selector - CENTERED position

(4) Place LH and RH landing gear ground safety switches in airborne position (refer to Chapter 32, LANDING GEAR).

<u>WARNING</u>: PRIOR TO PLACING LANDING GEAR SAFETY SWITCHES IN "AIRBORNE" POSITION, ASCERTAIN THAT ANTISKID SYSTEM IS TURNED OFF AND/OR MAIN WHEELS ARE PROPERLY CHOCKED.

(5) Close the following additional circuit breakers on the flight engineer's panel.

(a) Cabin and flight deck TURBO COMPR IND

(b) Cabin and flight deck TURBO COMPR OFF

(c) Cabin and flight deck TURBO COMPR ON

(d) HIGH DUCT PRESS WARN LT

(e) FUSE EXCESS HEAT WARN LT

(6) Ascertain that the following limiters have been installed:

(a) COND GND COOL CABIN

(b) FREON COND CABIN

(c) CABIN FLIGHT DECK RECIRC FAN MOTOR

(d) FREON COND FLT DECK

(e) COND GND COOL FLT DECK

(7) Connect and apply external source of air pressure (40 psig) to ground high pressure connection.

(8) Close CABIN and FLIGHT DECK HEATER circuit breakers in Freon package compartments.

<u>CAUTION</u>: ASCERTAIN THAT THE TURBOCOMPRESSORS HAVE BEEN SERVICED AND FILLED WITH OIL, SPECIFICATION MIL-L-6085 PRIOR TO STARTING OPERATIONS.

(9) Place cabin and flight deck AUTO-OFF-MAN temperature control switches in MAN position.

(10) Place RECIRCULATING BLOWER switch in ON position; recirculation fan shall start.

NOTE: On airplanes N801TW and N812TW through N830TW the recirculation air control valve shall open.

(11) Place and hold cabin and flight deck MAN HOT-MAN COLD temperature control switches in MAN COLD position for 2 minutes.

(12) Place FREON COMPRESSOR ON-OFF switch in ON position; cabin and flight deck Freon packages shall operate.

(13) Place cabin compressor AUTO-OFF-MAN ON switch in MAN ON position, and check for the following:

(a) Cabin turbocompressor shall start.

(b) Cabin COMPR RPM indicator shall indicate approximately 20,000 ($\pm$2000) RPM.

(c) Cabin COMPRESSOR AIR FLOW indicator shall indicate approximately 80-110 lbs/min.

(d) Cabin COMPR BEARING TEMP indicator shall indicate approximately 150 degrees ($\pm$10) F.

CAUTION: AN INCREASE IN TURBOCOMPRESSOR RPM MAY BE ACCOMPANIED BY A GRADUAL INCREASE IN BEARING TEMPERATURE. THIS INCREASE IN TEMPERATURE IS NORMAL, PROVIDED A MAXIMUM TEMPERATURE OF 250°F (121.1°C) IS NOT EXCEEDED. HOWEVER, AN ABRUPT INCREASE IN BEARING TEMPERATURE NOT ACCOMPANIED BY AN INCREASE IN RPM IS CAUSE FOR IMMEDIATE SHUTDOWN OF THE TURBO-COMPRESSOR BEFORE THE MAXIMUM TEMPERATURE LIMIT IS REACHED.

(14) Place RECIRCULATING BLOWER switch in OFF position; recirculation fan shall stop.

NOTE: On airplanes N801TW and N812TW through N830TW recirculation control valve shall close.

(15) Place three BLEED AIR DUCT ISOLATION switches in AUTO position (overhead switch panel) and check for the following:

(a) RH bleed air duct isolation valve shall open.

NOTE: Valve position can be ascertained in step (16) following. Valve is open if flight deck turbo-compressor is operable.

(16) Place flight deck COMPRESSOR AUTO-OFF-MAN ON switch in MAN ON position; check for same indications as in step (13) above. When flight deck turbocompressor operation is ascertained, place cabin COMPRESSOR AUTO-OFF-MAN ON switch in OFF position; cabin turbocompressor shall stop.

(17) Place cabin COMPRESSOR AUTO-OFF-MAN ON switch in MAN ON position; cabin turbocompressor shall start.

(18) Note the position of the cabin and flight deck turbocompressor heat control modulating valves.

<u>CAUTION:</u> STEPS (19) AND (20) FOLLOWING SHALL BE ACCOMPLISHED AS QUICKLY AS POSSIBLE TO AVOID DAMAGE TO SYSTEM COMPONENTS DUE TO EXCESS HEAT.

(19) Place and hold cabin and flight deck MAN HOT-MAN COLD temperature control switch in the MAN HOT position (not to exceed 2 minutes) and check for the following:

(a) Cabin and flight deck Freon packages shall shut down.

(b) Cabin and flight deck turbocompressor heat control modulating valves shall open.

(c) Cabin and flight deck conditioned air supply temperature shall increase.

(d) Cabin and flight deck electric heaters shall be off.

(e) Cabin and flight deck heat exchanger cooling air modulating valves shall be closed.

(20) Place LH and RH landing gear ground safety switches in ground position.

(21) Simulate reverse thrust position of engine power control thrust reverse lockout mechanism by manually depressing plunger on thrust reverse position switch (lower switch) on engine fuel control torque box and check for the following:

(a) When switch is actuated, the cabin and flight deck turbocompressors shall stop and as switch is released, turbocompressors shall resume operation.

(22) Place LH and RH landing gear ground safety switches in airborne position (refer to Chapter 32, LANDING GEAR).

<u>WARNING:</u> PRIOR TO PLACING LANDING GEAR SAFETY SWITCHES IN "AIRBORNE" POSITION, ASCERTAIN THAT ANTISKID SYSTEM IS TURNED OFF AND/OR THE MAIN WHEELS ARE PROPERLY CHOCKED.

(23) Place cabin and flight deck MAN HOT-MAN COLD temperature control switches in MAN COLD position (not to exceed 2 minutes) and check for the following to occur.

(a) Cabin and flight deck turbocompressor heat control modulating valves shall close.

(b) Cabin and flight deck conditioned air temperature shall increase.

(c) Cabin and flight deck heat exchanger cooling air modulating valves shall open.

(d) Cabin and flight deck Freon packages shall operate.

(24) Rotate CABIN TEMP CONTROL and FLIGHT DECK TEMP CONTROL selectors to center position.

(25) Place cabin and flight deck AUTO-OFF-MAN temperature control switches in AUTO position.

(26) Allow system to stabilize in this configuration for approximately one minute.

(27) Place LH and RH landing gear ground safety switches in ground position (refer to Chapter 32, LANDING GEAR).

G. Operational Check of Ram Air Shutoff Valves

(1) Ascertain that RAM AIR SHUTOFF VALVE circuit breaker is closed.

(2) Hold RAM AIR SOURCE switch in OPEN position and check for the following:

(a) Cabin and flight deck ram air shutoff valve actuators shall rotate to the open position in two minutes.

NOTE: Ascertain actuator position by observing position indicator on valve. Valves are located near the top of the turbocompressor package compartments and aft of the compartment access doors.

(b) Ascertain that swinging gates on valves can be opened manually by applying a slight inward pressure on gates; there shall be no binding.

(3) Hold RAM AIR SOURCE switch in CLOSE position and check for the following:

(a) Cabin and flight deck ram air shutoff valve actuators shall rotate to the closed position in two minutes.

(b) Ascertain that swinging gates on valves do not open when a moderate inward pressure is applied to gates.

H. Shut Down Air Conditioning System.

(1) Place switches on air conditioning and pressurization control panel in following positions:

(a) Cabin and flight deck turbocompressor AUTO-OFF-MAN ON switches - OFF.

(b) RECIRCULATING BLOWER switch - OFF.

(c) FREON COMPRESSOR ON-OFF switch - OFF.

(d) FREON COMPRESSOR FLT DECK OFF - BOTH ON - CABIN OFF switch - CABIN OFF.

(e) RAM AIR SOURCE switch - CLOSE

(f) AUTO-OFF-MAN temperature control switches - OFF

(2) Disconnect and remove ground electrical and pneumatic power carts from airplane.

(3) Close air conditioning and pressurization compartment access doors.

2. Air Conditioning System Air Control Valve Electrical "Quick Check"

A. General.

This procedure is not intended as a thorough check of the entire air conditioning system, but rather as a quick check for electrical operation of the individual valves.

To check the operation of the entire air conditioning package, refer to Adjustment/Test Air Conditioning and Pressurization System in this section.

B. Equipment Required.

(1) External source of 115/200-volt, 3-phase, 400 cps ac electrical power (refer to Chapter 24, ELECTRICAL POWER).

(2) Hair drier, or equivalent, to simulate an increase in air temperature.

C. Perform Check of Air Control Valves.

(1) Connect external electrical power to airplane (refer to Chapter 24, ELECTRICAL POWER).

(2) Check conditioned air emergency shutoff and crossover shutoff valves for electrical operation as follows:

(a) Close RECIRC FAN CONT, AIR FLOW IND, EVAP AIR MANF SHUTOFF VALVE and CAB FLT DECK AIR SHUTOFF circuit breakers.

(b) Place RECIRCULATING BLOWER switch in ON position (allow 10 to 15 seconds for recirculation air control valve to open and fan to start).

<u>NOTE:</u> In the following steps the COMPRESSOR AIR FLOW indicator on the flight engineer's panel can be used to ascertain the position of the valves being checked.

(c) Place Freon compressor FLT DECK OFF-BOTH ON-CABIN OFF switch in BOTH ON position; both conditioned air emergency shutoff valves shall open (if not already open) and crossover shutoff valve shall close. The COMPRESSOR AIR FLOW indicator shall register approximately 85 pm (pounds per minute) airflow for cabin and flight deck.

(d) Place Freon compressor FLT DECK OFF-BOTH ON-CABIN OFF switch in CABIN OFF position; cabin conditioned air emergency shut off valve shall close and crossover shutoff valve shall open. Airflow indicator shall register no flow for cabin side and increased flow (approximately 165 pm) for flight deck side.

(e) Repeat step (d) substituting FLT DECK OFF position for CABIN OFF; valve response and airflow indications for the flight deck side shall be the same as the cabin side.

(f) When test is complete place Freon compressor FLT DECK OFF-BOTH ON-CABIN OFF switch in BOTH ON position and place RECIRCULATING BLOWER switch in OFF position. Open circuit breakers which were closed at beginning of test.

(3) Check condenser ground cooling shutoff valves for electrical operation as follows:

<u>NOTE:</u> The condenser ground cooling air shutoff valves are normally open when the airplane is groundborne.

(a) Close CAB and FLT DECK COND GRD COOL circuit breakers.

<u>WARNING:</u> PRIOR TO PERFORMING STEP (b) ASCERTAIN THAT ANTISKID AND TAIL DE-ICE SYSTEMS ARE TURNED OFF.

(b) Open LDG GEAR GRD SAFETY SW circuit breakers; condenser ground cooling shutoff valves shall close. Close LDG GEAR SAFETY SW circuit breakers and valves shall open.

(4) Check condenser cool air modulating valves for electrical operation as follows:

NOTE: The condenser cool air modulating valves are normally closed when the airplane is groundborne.

(a) Start and operate Freon packages in either automatic or manual mode. Operate Freon packages in "full cold" until frost is visible at Freon compressor, or condenser fan discharge air is warm. (Condenser fan discharge is at forward bulkhead of main wheel well.)

WARNING: PRIOR TO PERFORMING STEP (b) ASCERTAIN THAT ANTISKID AND TAIL DE-ICE SYSTEMS ARE TURNED OFF.

(b) Open both LDG GEAR GRD SAFETY SW circuit breakers; condenser cool air modulating valves shall open.

(c) As soon as valves are fully open, place FREON COMPRESSOR ON-OFF switch in OFF position (this will prevent a lockout of Freon package); close LDG GEAR GRD SAFETY SW circuit breakers and condenser cool air modulating valves shall close.

(5) Check heat exchanger cool air modulating valve and turbocompressor heat control modulating valve for electrical operation (automatic mode) as follows:

(a) Place flight deck temperature control AUTO-OFF-MAN switch in AUTO position.

(b) Rotate FLIGHT DECK TEMP CONTROL selector to full increase (clockwise) position; flight deck heat exchanger cool air modulating valve shall close.

NOTE: In order to obtain the desired valve response, it may be necessary to simulate an increased air temperature by heating the temperature sensors with a hair drier.

(c) When heat exchanger cool air modulating valve is closed, the flight deck turbocompressor heat control modulating valve shall open.

(d) Rotate FLIGHT DECK TEMP CONTROL selector to full decrease (counterclockwise) position; turbocompressor heat control modulating valve shall close. Heat exchanger cool air modulating valve shall open when turbocompressor heat control modulating valve is fully closed.

WARNING: PRIOR TO PERFORMING STEP (e) ASCERTAIN THAT ANTISKID AND TAIL DE-ICE SYSTEMS ARE TURNED OFF.

(e) Open RH and LH LDG GEAR GRD SAFETY SW circuit breakers and repeat steps (a) through (d) substituting cabin for flight deck; results shall be the same as obtained for the flight deck heat exchanger cool air modulating valve and flight deck turbocompressor heat control modulating valve.

(f) Place AUTO-OFF-MAN switch in OFF position and close circuit breakers when check is complete.

(6) Check heat exchanger cool air modulating valve and turbocompressor heat control modulating valve electrical operation (manual mode) as follows:

(a) Place flight deck temperature control AUTO-OFF-MAN switch in MAN position.

(b) Toggle MAN HOT - MAN COLD temperature control switch to MAN HOT position; flight deck heat exchanger cool air modulating valve shall close and flight deck turbocompressor heat control modulating valve shall open.

(c) Toggle MAN HOT-MAN COLD temperature control switch to MAN COLD position; turbocompressor heat control modulating valve shall close and heat exchanger cool air modulating valve shall open.

<u>WARNING:</u> PRIOR TO PERFORMING STEP (d) ASCERTAIN THAT ANTISKID AND TAIL DE-ICE SYSTEMS ARE TURNED OFF.

(d) Open RH and LH LDG GEAR GRD SAFETY SW circuit breakers and repeat steps (a) through (c) substituting cabin for flight deck; results shall be the same as obtained for flight deck valves.

(e) Close RH and LH LDG GEAR GRD SAFETY SW circuit breakers when test is complete.

(7) Check recirculation air control valve for electrical operation as follows:

<u>NOTE:</u> This check is applicable only to those airplanes not equipped with fresh air valves.

(a) Close RECIRC FAN CONT circuit breakers.

(b) Place RECIRCULATING BLOWER switch in ON position; recirculation air control valve shall open within 10 to 15 seconds; when valve is fully open, the recirculation fan shall start.

(c) Place RECIRCULATING BLOWER switch in OFF position; recirculation fan shall stop and recirculation air control valve shall close.

(8) Check recirculation and fresh air control valves for electrical operation (automatic mode) as follows:

NOTE: This check is applicable to those airplanes equipped with both the recirculation and fresh air control valves.

(a) Trip the No. 3 BTB (this will prevent the recirculation blower from operating).

(b) Open CABIN and FLIGHT DECK HEATER circuit breakers in Freon package compartment.

(c) Place RECIRCULATING BLOWER switch in ON position.

(d) Place temperature control AUTO-OFF-MAN switch in AUTO position and rotate TEMP CONTROL selector to full increase (clockwise) position.

(e) Recirculation air control valve and fresh air control valve response shall be as follows:

Starting from full cold position on sequencing device, and traveling toward full hot position, the first quadrant of travel shall result in the recirculation valve closing and fresh air valve opening. Both valves shall remain in this configuration until the beginning of the fourth quadrant of travel. During the fourth quadrant, the fresh air valve shall close and recirculation valve shall open.

(f) Place RECIRCULATION BLOWER switch in OFF position; recirculation valve shall close and fresh air valve shall remain closed.

(9) Check fresh air valve and recirculation valve in manual mode operation as follows:

(a) Place temperature control AUTO-OFF-MAN switch in MAN position and repeat steps (8)(a) through (8)(f); results of valve travel shall be the same.

(b) Place RECIRCULATING BLOWER switch in OFF position.

(c) Close No. 3 BTB, and close CABIN and FLIGHT DECK HEATER circuit breakers.

PRESSURIZATION SUBSYSTEM - DESCRIPTION AND OPERATION

1. General

To distinguish between the pressurization subsystem and the air conditioning subsystem it is necessary to recognize the different functions of some of the components and subsystems. The primary function of the pressurization subsystem is to pressurize the airplane. The primary function of the air conditioning subsystem is to condition the air directed to the flight and passenger compartments for passenger and crew comfort. The primary function of the turbocompressor is to pressurize air for cabin pressurization but, as the air is pressurized, it is also heated; this is a function of the air conditioning subsystem. If warmer air is needed for the air conditioning subsystem the air can be recirculated through the turbocompressor. This is accomplished by the heat control modulating valve when warmer air is called for. Consider the turbocompressor and the heat control modulating valve as being a part of the pressurization subsystem although they also function as a part of the air conditioning subsystem. The pressure regulator and outflow valves and pressurization controls are concerned with pressurization only. The pressurization control subsystem is covered in 21-2-0, PRESSURIZATION CONTROLS AND INDICATION.

The 17th stage of each of the four turbojet engine compressors provides a source of bleed air with a maximum pressure of 237 psig and a maximum temperature of 867 degrees (464 degrees C). The engine bleed air valves regulate the pressure to 40 (±5) psig. For more details on the bleed air system, refer to Chapter 36, PNEUMATICS. This bleed air is ducted from the bleed air supply line or manifold to the variable area nozzle in the turbine section of the turbocompressor when the turbocompressor shutoff valve is in the open position. The turbocompressor shutoff valve is electrically controlled by its respective ON-OFF switch and reverse thrust switch, as well as being pneumatically controlled by the overspeed cutout. The bleed air from the variable area nozzle rotates the turbocompressor turbine and is then exhausted directly overboard. As the turbine rotates, it turns an impeller to draw in ambient ram air from the plenum chamber and compress it for cabin pressurization and air conditioning. The compressor impeller is mounted on the same shaft as the turbine. To provide heated pressurized air, as prescribed by the temperature control system, the heat control modulating valve recirculates a portion of the pressurized air back through the compressor to increase its temperature. This reheated air is limited to approximately 240 degrees F (116 degrees C) by a temperature limiter control that senses compressor outlet air temperature. The heated air then passes through a flow control sensor and enters the primary and secondary cooling stages before being discharged into the cabin and flight compartment. Refer to 21-3-0, AIR CONDITIONING SUBSYSTEM for a description of the cooling of pressurized air.

The conditioned air, after it is discharged into the cabin and flight compartment, is then directed to the forward and aft cabin pressure regulator and outflow valves. For a more detailed explanation of the air distribution system refer to 21-8-0, AIR DISTRIBUTION SYSTEM. Section 21-2-0 covers the

pressurization control and indication. Outflow of air from the pressurized areas of the fuselage is controlled through the cabin pressure regulators and outflow valves. The outflow valves restrict air flow to maintain a cabin pressure as called for by the pressurization control subsystem. In the event one outflow valve should malfunction the other outflow valve is capable of maintaining a normal cabin pressure regulation schedule.

The maximum capacity of the pressurization subsystem is a mass flow of 160 pounds per minute at sea level and varies approximately linearly with altitude to 120 pounds per minute at 35,000 feet.

In the event the flight compartment lost pressure during normal flight, due to a windshield blowing out or other similar failure, cabin-to-flight compartment pressure would be equalized through operation of a blowout panel. The blowout panel is installed in the aft partition of the flight compartment which separates the flight compartment from the cabin area. When flight compartment pressure is lost, cabin pressure will force the blowout panel into the flight compartment. Blowout will occur only at a maximum differential pressure between the flight compartment and cabin.

2. Description

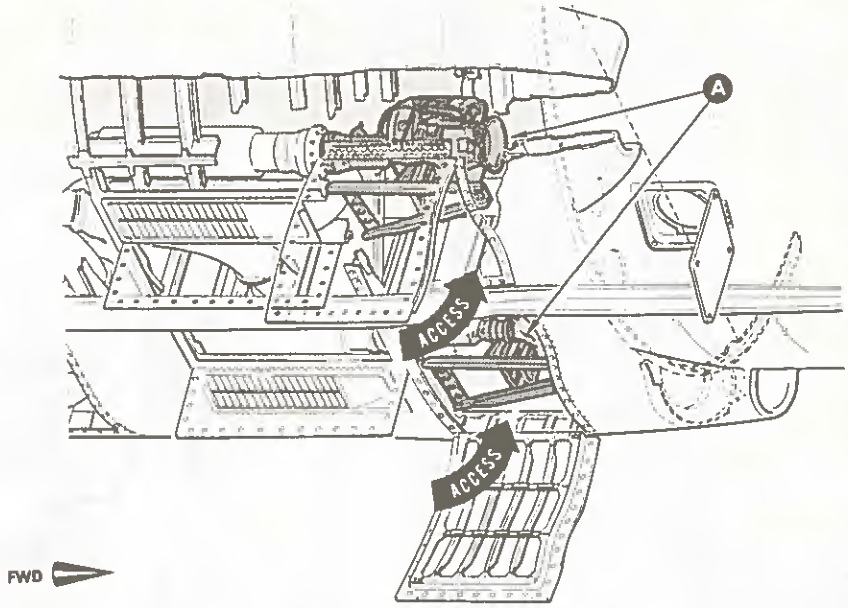
The turbocompressor assembly (see Figure 1) is a pneumatically driven, air pressurizing assembly consisting of a turbine-powered centrifugal compressor equipped with controls, sensors, and indicating devices. The turbocompressor, using engine bleed air to drive the turbine, compresses fresh ram air in the compressor section. The pressurized fresh air is supplied to the air conditioning and pressurization system at a proper weight flow and pressure to pressurize the cabin and flight compartments of the airplane.

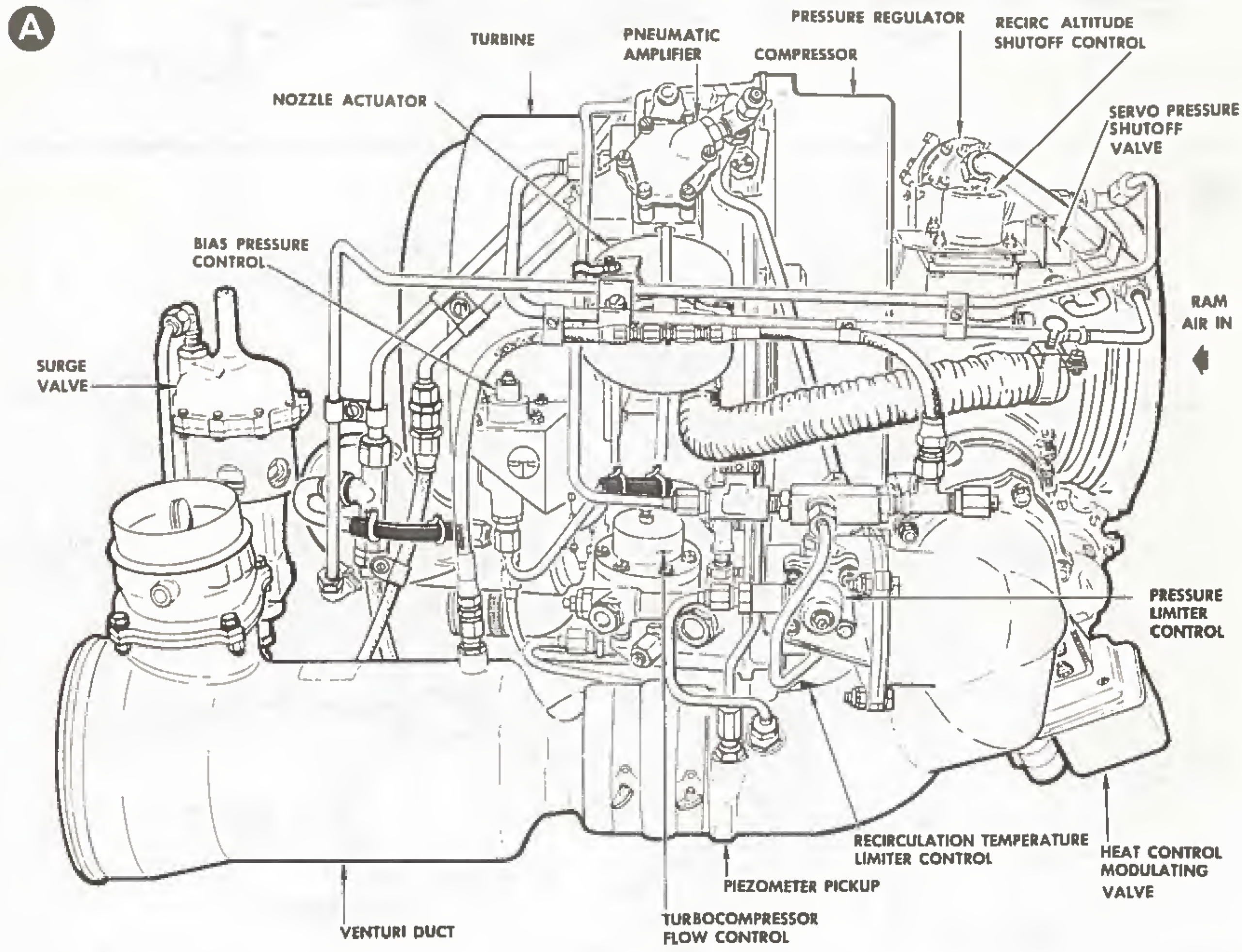
A. Turbocompressor.

The turbocompressor is a single-stage centrifugal compressor of radial-flow configuration powered by a turbine rotor. The turbine section is equipped with a throttling device consisting of a variable area nozzle which is controlled by the weight flow demand of the flow sensor. The compressor section contains an impeller constructed with straight radial vanes making a 90 degree intersection with the periphery. Ambient air, which is compressed, flows from the impeller through vaned diffusers into a scroll case where a single main flow outlet discharges the compressed air into the primary heat exchanger and then to the Freon evaporator and into the cabin and flight compartment distribution subsystems.

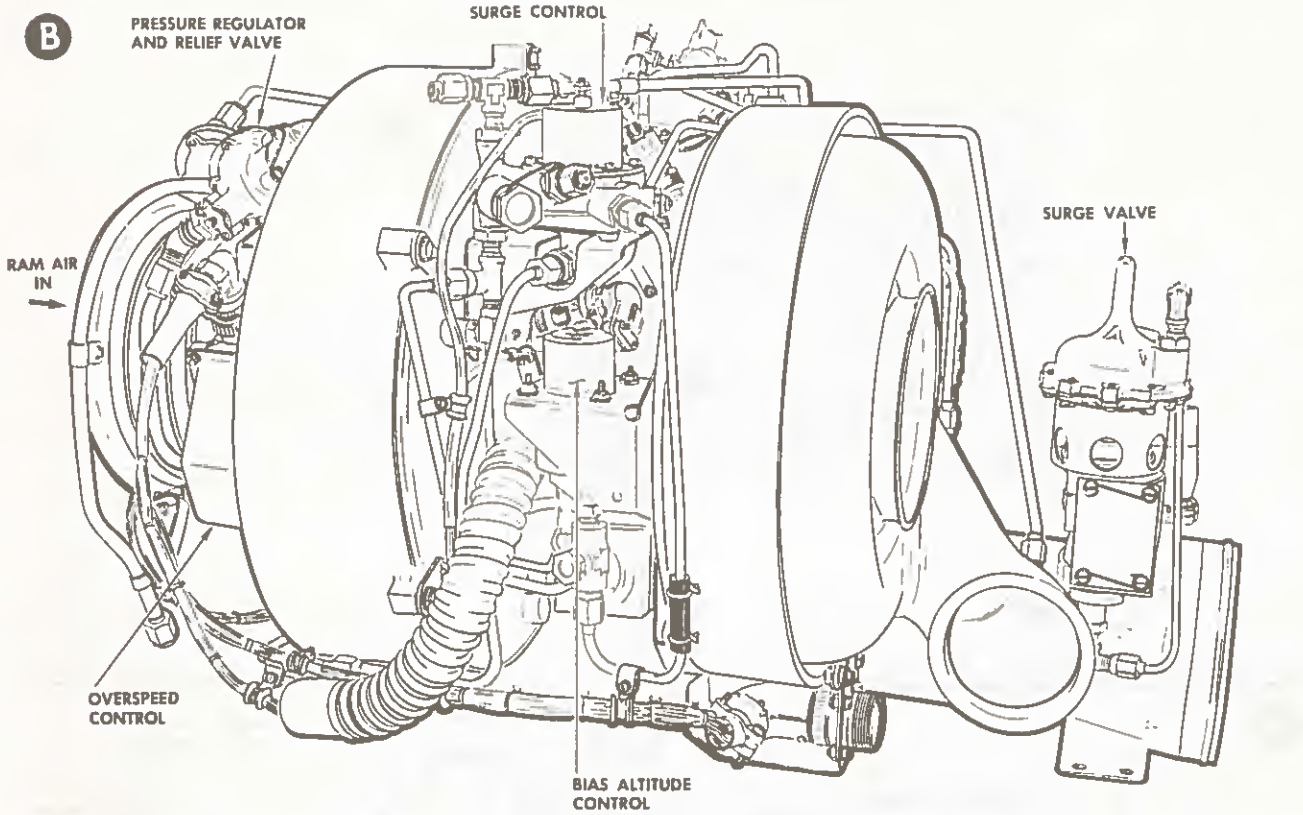
B. Lubrication and Cooling.

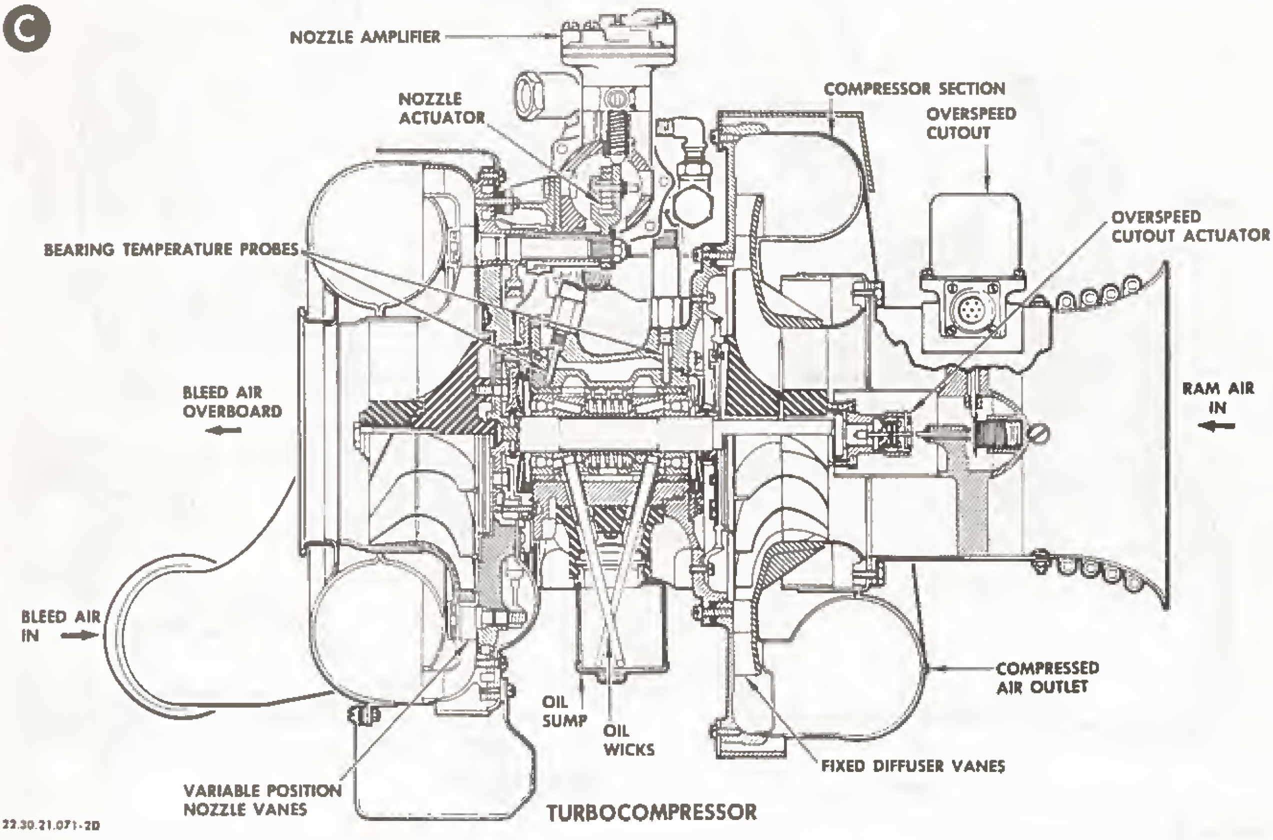
Both the turbine rotor and the impeller are mounted on a common shaft, supported by ball bearings which are lubricated by a wick feed and impeller discharge system whereby oil is supplied to the bearings by the wicks and drawn through the bearings by the oil impellers. From the oil impellers the oil is returned to the sump. Each bearing is also equipped with a temperature sensor to provide signals to a control unit which, in turn, translates these signals into control voltage to operate a temperature indicator on the flight engineer's control panel.





Turbocompressor Assembly
Figure 1 (Sheet 1 of 2)





Turbocompressor Assembly
Figure 1 (Sheet 2 of 2)

C. Overspeed Cutout.

A flyweight overspeed cutout assembly is incorporated on the compressor end of the turbocompressor shaft. Overspeed of the compressor is prevented by the overspeed cutout feature which actuates only when the compressor reaches a predetermined speed above normal operating speeds. Should an excess speed be reached, centrifugal force causes the flyweights to move radially outward and shift an actuator axially. The actuator trips the cutout to actuate a switch which interrupts voltage to the turbocompressor shutoff valve solenoid "open" winding and applies voltage to the "close" winding of the solenoid to close the shutoff valve. The actuator also opens a poppet valve to vent servo pressure from the "open" chamber of the turbocompressor shutoff valve and actuates a switch which lights an overspeed warning light on the flight engineer's control panel. Operation of the overspeed cutout renders the turbocompressor inoperative until the cutout can be reset manually (airplane on the ground).

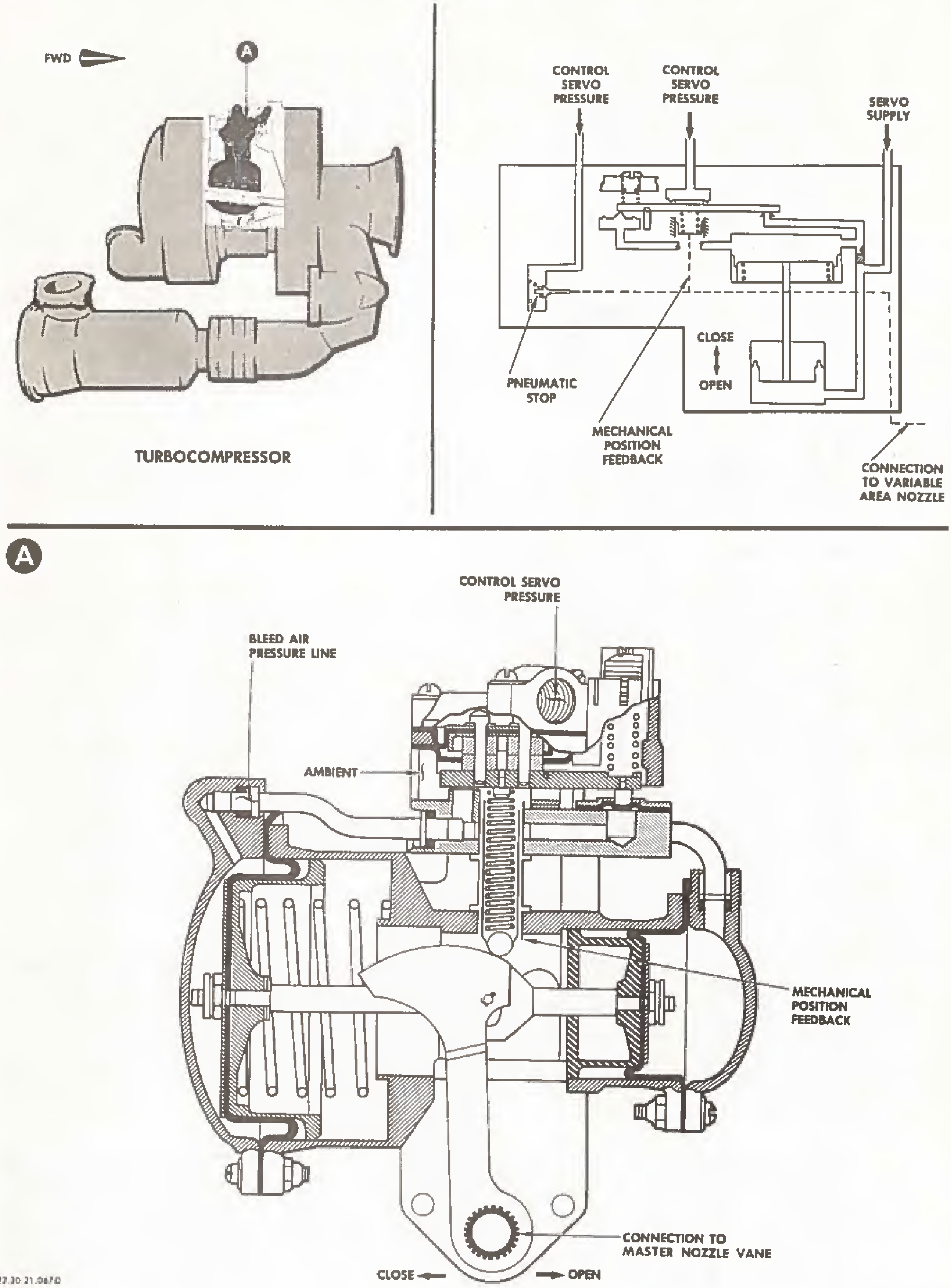
A rotor speed pickup is incorporated at the compressor to transmit shaft speed signals to the turbocompressor rpm indicator on the flight engineer's control panel.

D. Turbocompressor Nozzle Actuator.

The turbocompressor nozzle actuator, illustrated on Figure 2, is part of the turbocompressor and consists of differential pistons in dual pressure chambers. The pistons are mechanically linked to the turbine nozzle vanes. A servo tube connects both actuator chambers to a source of servo pressure (engine bleed air). The servo tube to the actuator chambers is also connected to a vent that is restricted by the amplifier lever of the pneumatic amplifier. A second servo tube connects the flow control and pressure limiter control to the pneumatic amplifier. The diaphragm operated pistons, connected by a common actuator shaft, are spring-loaded toward the nozzle vane closed position. The actuator shaft connects with the master nozzle vane shaft by a drive lever. A lever arm cam follower connects to the diaphragm operated amplifier piston lever. A poppet valve on the turbocompressor is positioned in line with the actuator drive lever arm.

Nozzle actuator operation can be ascertained by following the schematic illustrated in Figure 2. Servo pressure supplied to both actuator chambers drives the large piston against the spring load to rotate the master nozzle vane toward the nozzle open position. Greater force on the larger diaphragm causes this movement. The master vane drives the other nozzle vanes by turning a ring gear to which each vane is meshed by a gear segment.

As the actuator moves toward the nozzle open position, a feed back cam drives a cam follower to increase spring tension under the amplifier piston lever. The increased spring force tends to move the piston against servo pressure supplied to the amplifier which would then move the amplifier lever away from a vent. The vent permits servo pressure in the large actuator chamber to escape, tending to close the nozzle



Turbocompressor Nozzle Actuator
Figure 2

vanes due to the pressure on the small diaphragm. The amplifier lever reaches an intermediate position that balances pressure on the amplifier diaphragm with feedback spring tension determined by actuator position. The actuator balance is controlled by the servo pressure supply to the amplifier chamber which in turn is subject to regulation by the flow and pressure limiter controls. The maximum pressure limit in the actuator is set by the poppet valve which bleeds off pressure to maintain the minimum pressure for the full-open nozzle condition. Servo control pressure is amplified by the larger actuating area of the diaphragm operated piston in the amplifier. The controls affect rotor speed by bleeding off servo pressure which tends to close the nozzle vanes by opening the amplifier vent from the large actuator.

E. Pressure Limiter Control.

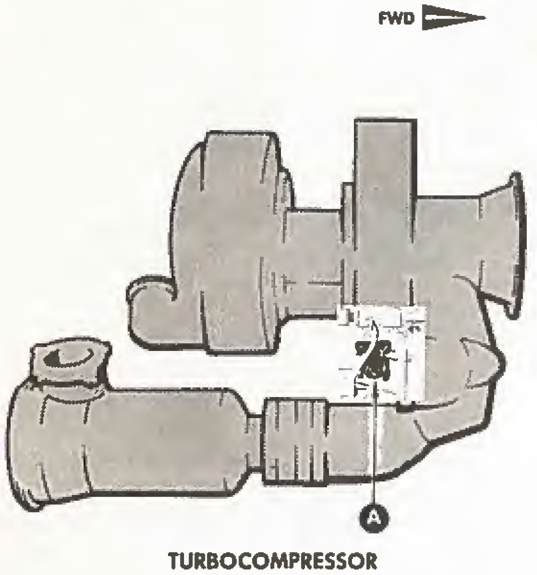
The pressure limiter control, shown on Figure 3, consists of a housing, with a pressure sensing chamber and a diaphragm operated poppet valve. A sensing tube connects the central control chamber to the pressure pickup on the transition outlet duct near the piezometer ring. Servo tubing from the flow control to the pneumatic amplifier of the nozzle actuator is connected by a tee to the vent under the poppet. The diaphragm piston is spring-loaded toward the closed poppet position.

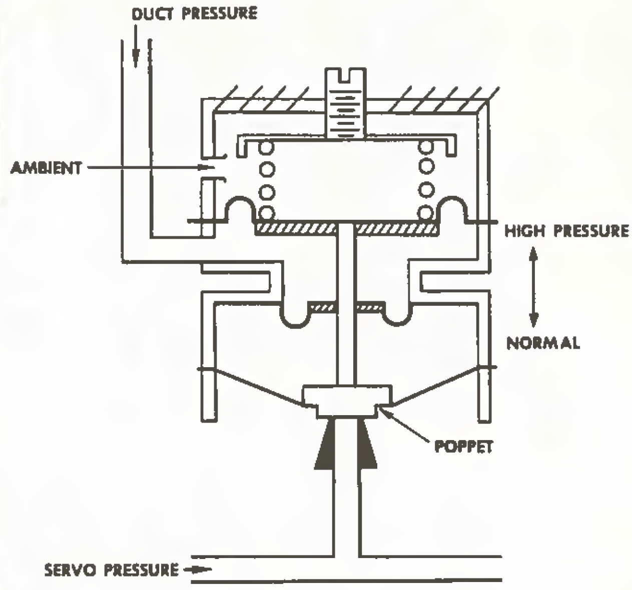
The pressure limiter limits output pressure by controlling turbocompressor rpm. An increase in compressor outlet pressure, approaching maximum pressure, moves the piston and poppet away from the servo tube vent. The open poppet reduces servo pressure to the nozzle actuator which causes the nozzle vanes to move toward the closed position, thereby reducing rotor speed. Normal operating conditions permit spring load to hold the poppet closed.

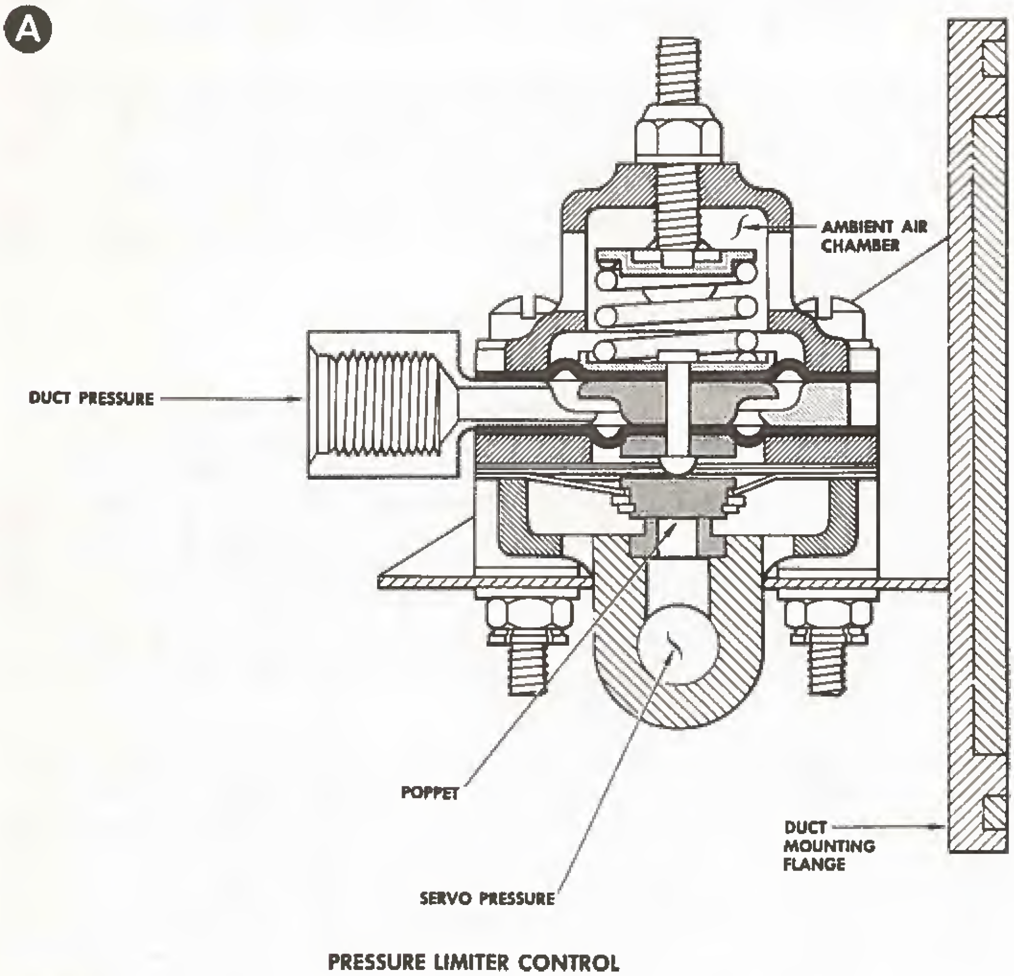
F. Turbocompressor Surge Control.

The turbocompressor surge control, shown on Figure 4, consists of a housing with diaphragm separated chambers containing spring-loaded pistons. Two additional diaphragms are held to the pistons and the pistons are linked to a poppet valve. The lower chamber is vented to ambient through an orifice connected to the bias altitude control. The lower chamber is also connected through an adjustable orifice to a sensing line from the bias altitude control and piezometer. The upper chamber is connected to a sensing line from the venturi. The poppet is held over a vent on one leg of a tee which is in the servo line from the pressure regulator to the surge valve.

The surge control senses compressor discharge weight flow and pressure, and controls the servo pressure supply to the surge valve. Pressure within the duct at the piezometer is normally greater than the pressures picked up at the venturi. The duct pressure is supplied to the control chamber which is spring-loaded toward the poppet open position. Venturi pressure which varies with weight flow and pressure, is supplied to the control chamber which is spring-loaded toward the poppet closed position. Duct pressure is greater than venturi pressure during normal operating conditions, thus the poppet is held closed. With the poppet

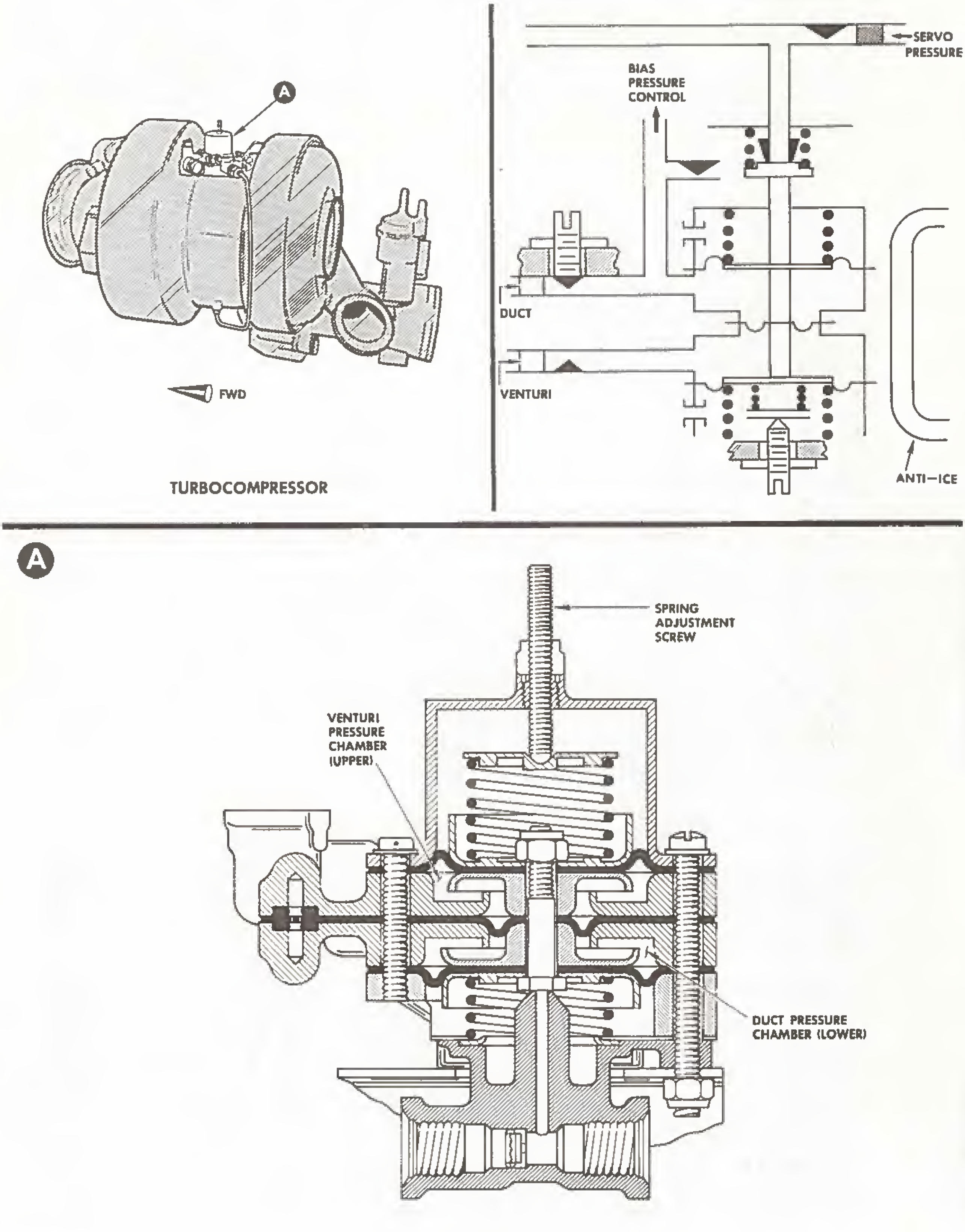






22.30.21.048C

Pressure Limiter Control
Figure 3



TURBOCOMPRESSOR SURGE CONTROL

72 30 21 081 B

closed, the servo line supplies sufficient servo pressure to the surge valve to hold the valve closed. Should compressor flow approach surge conditions, the difference between duct and venturi pressure decreases sufficiently to permit the venturi pressure within the surge control to open the poppet. The open poppet vents surge valve servo pressure which opens the surge valve.

G. Turbocompressor Flow Control.

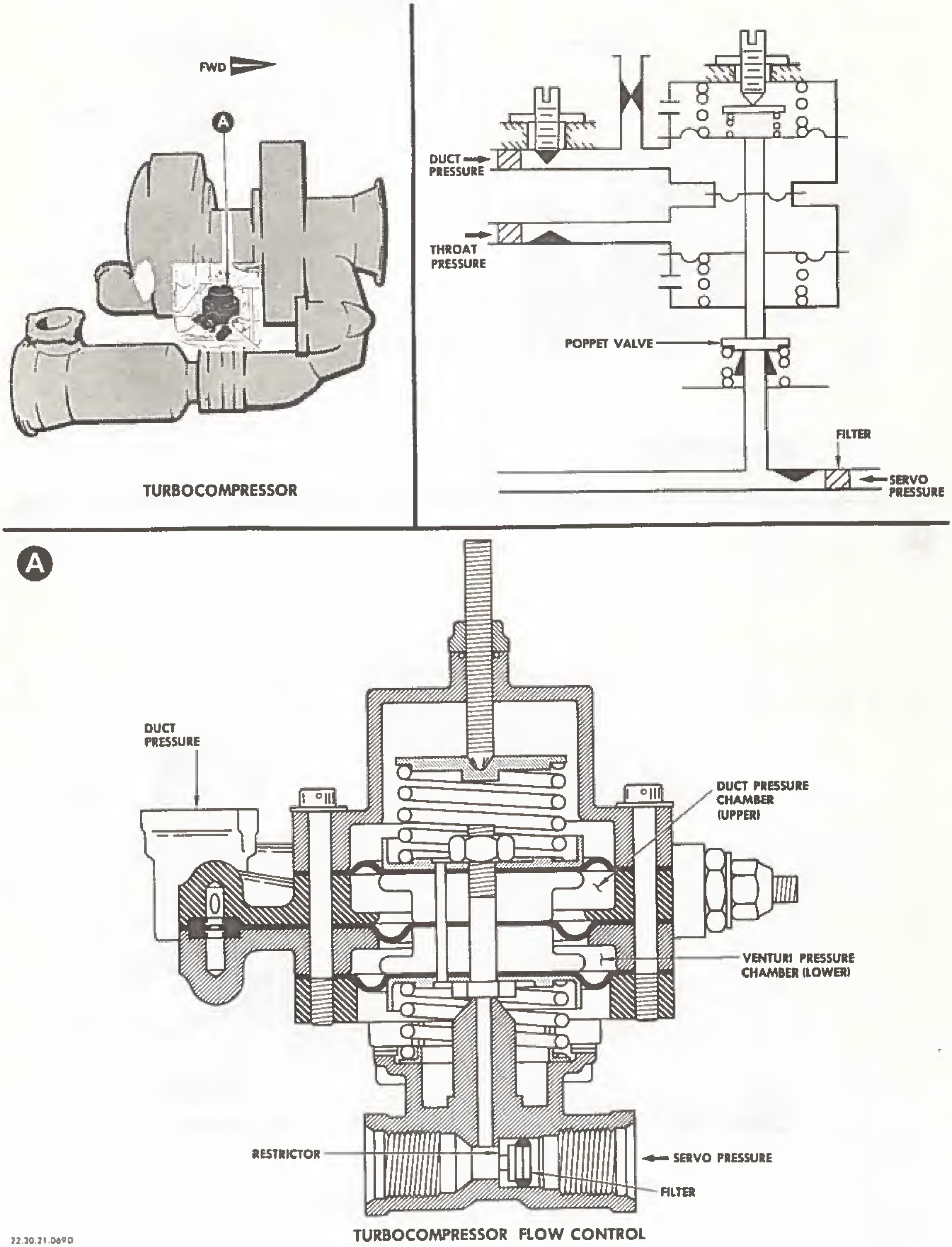
The turbocompressor flow control, illustrated on Figure 5, consists of a housing with diaphragm separated chambers containing spring-loaded pistons. Two additional diaphragms are held to the pistons which are linked to a poppet valve. The upper or duct pressure chamber of the flow control is vented to ambient through a choked orifice and is also connected through an adjustable orifice to a sensing line from a piezometer ring upstream of the venturi. The lower or throat pressure chamber is connected to a sensing line from the constriction of the venturi duct. Both the venturi and piezometer sensing lines are connected to a bias pressure control. The poppet is held over a vent on one leg of a tee in the servo line between the pressure regulator upstream, and the pressure limiter control and nozzle actuator downstream.

Flow control operation can be ascertained by following the schematic illustrated in Figure 5. The flow control senses turbocompressor output and limits the discharge flow by controlling rotor rpm. Pressure at the venturi throat decreases as flow increases. This pressure is supplied to the throat pressure chamber. A higher duct pressure from the piezometer pickup ring is supplied to the duct pressure chamber, tending to open the poppet. Normal operating conditions balance the opposing forces and hold the poppet in a partially open position. The fully open poppet will reduce servo pressure to the nozzle actuator amplifier which will cause the nozzle vanes to move toward the closed position thereby reducing rotor speed.

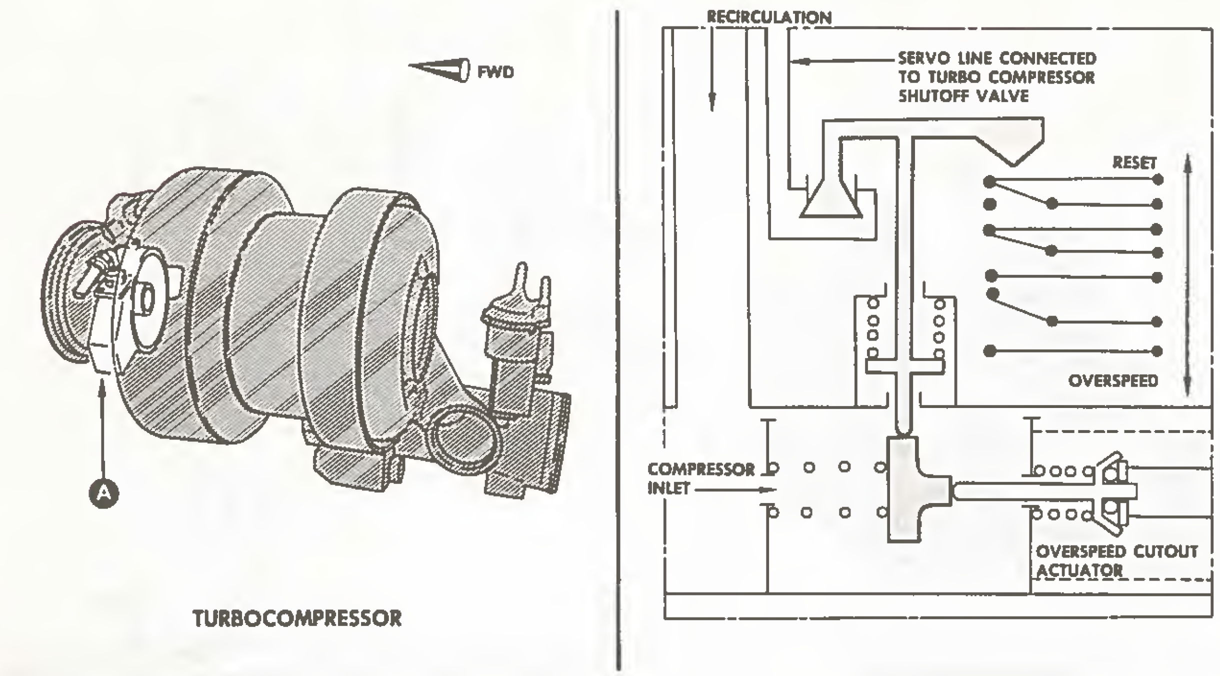
H. Turbocompressor Overspeed Control.

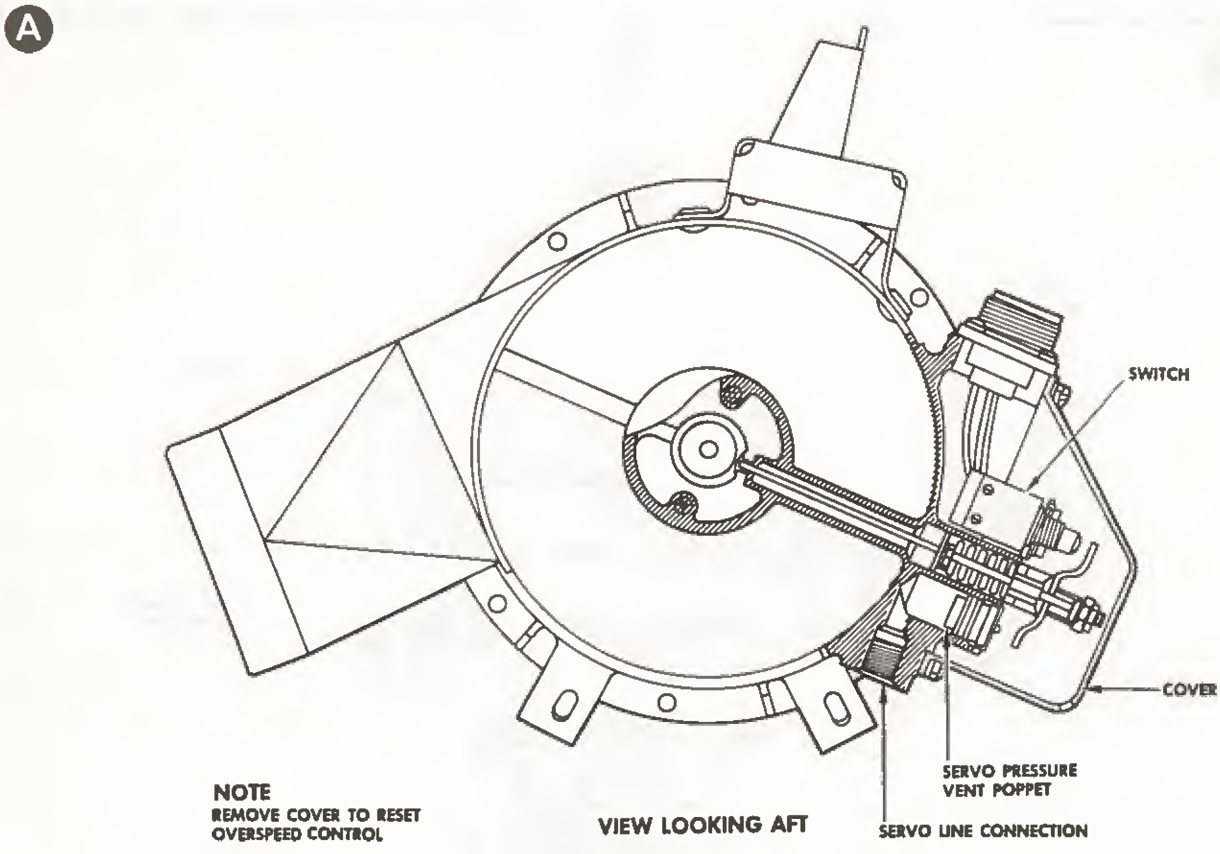
The overspeed control is an inlet-connecting duct with an overspeed switch, poppet and an actuating mechanism. The overspeed control is a part of the turbocompressor. The overspeed control circuit is illustrated on Figure 6.

A connecting duct joins the ram air inlet to the compressor inlet and contains a side port, connecting with the heat control modulating valve in the recirculation duct. The overspeed tripping mechanism of the control is held in line with the actuator pin of the overspeed cutout actuator on the rotor shaft. The switch is wired to the turbocompressor shutoff valve solenoid and, external to the turbocompressor, to the reverse thrust switch, turbocompressor ON-OFF switch, and the over-speed indicating light. The poppet is held in the closed position mechanically and is spring-loaded to open the turbocompressor shutoff valve servo vent line when the control actuator trips the overspeed control.



Turbocompressor Flow Control
Figure 5





TURBOCOMPRESSOR OVERSPEED CONTROL

22.30.21.070 B

Turbocompressor Overspeed Control
Figure 6

The overspeed control is a safety device that provides means for shutting down the turbocompressor when rotor speeds exceed a preset maximum rpm. Normal turbocompressor operation is provided by a closed circuit through the switch, supplying 28-volt dc power to the "on" winding of the turbocompressor shutoff valve on-off solenoid. When rotor rpm becomes excessive, the overspeed cutout actuator trips the overspeed control, actuating the switch and opening the poppet. The open poppet vents servo air supply to the large actuator chamber of the shutoff valve, closing the valve. When the switch actuates, the circuit to the solenoid "open" winding is broken, a circuit to the overspeed indicating light is made and 28-volt dc power is supplied through a third circuit to the solenoid "close" winding opening the solenoid poppet. The open solenoid poppet also vents the large actuator chamber closing the valve. The turbocompressor is then inoperative until the overspeed control is reset manually.

I. Bias Pressure Control.

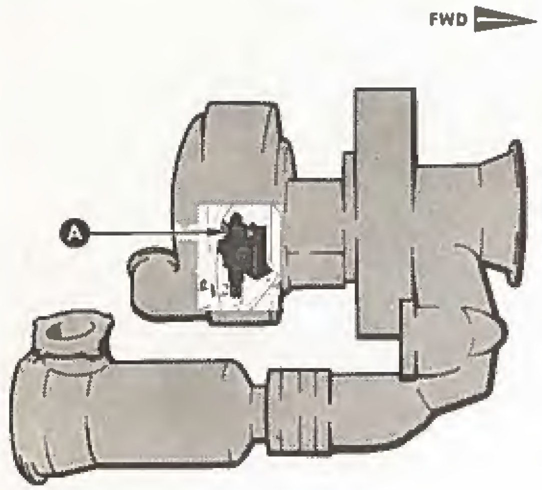
The bias pressure control (see Figure 7) consists of a diaphragm operated piston and a poppet valve. The venturi and piezometer pressure sensing lines that lead to the flow control are connected into the bias control on opposite sides of the poppet valve. Ambient pressure opposes piezometer pressure across the control diaphragm. When ambient pressure exceeds duct pressure plus spring tension on the piston, the piston actuates the poppet valve and feeds piezometer pressure to the venturi sensing line. Biasing the flow control sensing pressure increases the turbocompressor output flow.

3. <u>Turbocompressor Operation</u>

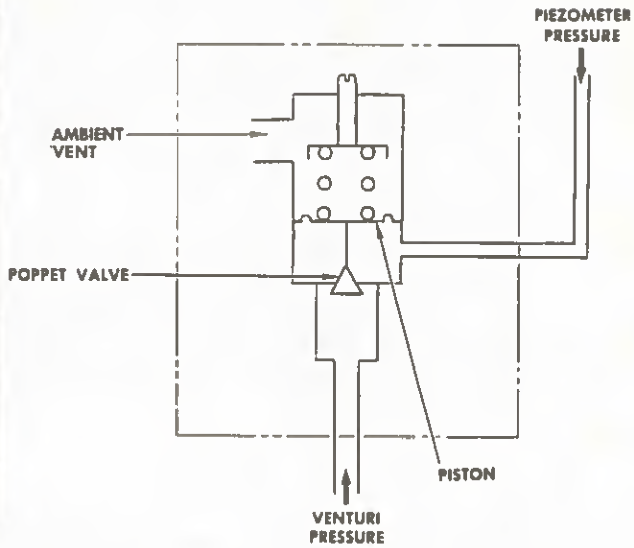
The turbocompressor operates as a single stage compressor in which a single impeller supplies pressurized air to the air conditioning subsystem. Engine bleed air is directed against the turbine rotor blades to drive the turbine and compressor, then discharged overboard. Fresh air drawn into the compressor inlet is pressurized by the centrifugal force of the compressor impeller and is discharged into the air conditioning system ducting.

A. Turbocompressor Control.

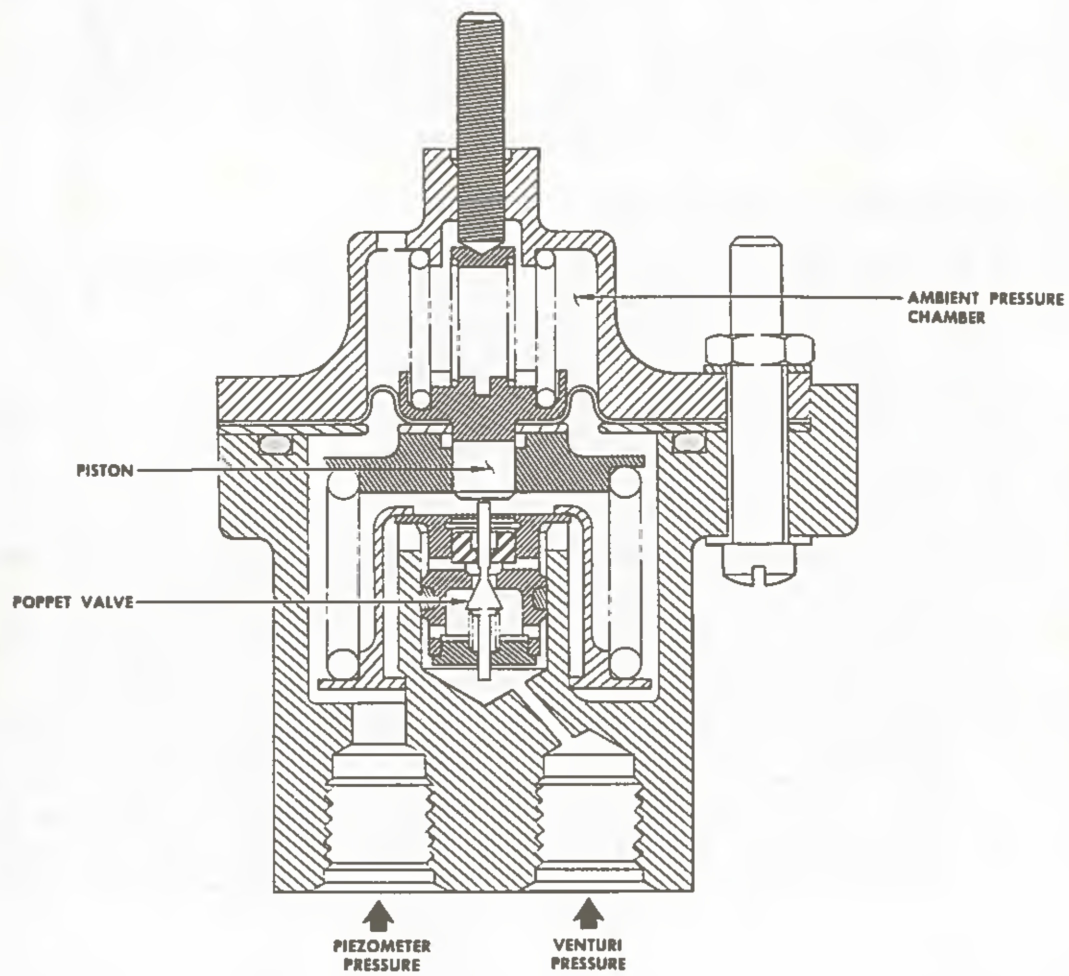
Turbocompressor control illustrated in Figure 8 is achieved basically through actuation of the turbocompressor shutoff valve. The shutoff valve is a pneumatically operated butterfly valve and is controlled by an electrical solenoid. Refer to 21-1-1, TURBOCOMPRESSOR SHUTOFF VALVE, for further details of the turbocompressor shutoff valve. Power to operate the shutoff valve solenoid is supplied through four sources; (1) the turbocompressor ON-OFF switch, (2) the reverse thrust switch, (3) the overspeed cutout switch, and (4) the landing gear ground safety relay. Thus, whenever the ON-OFF switch is ON, no reverse thrust called for, and the overspeed switch is not tripped, the turbocompressor shutoff valve opens to permit the flow of bleed air to the turbocompressor.



TURBOCOMPRESSOR

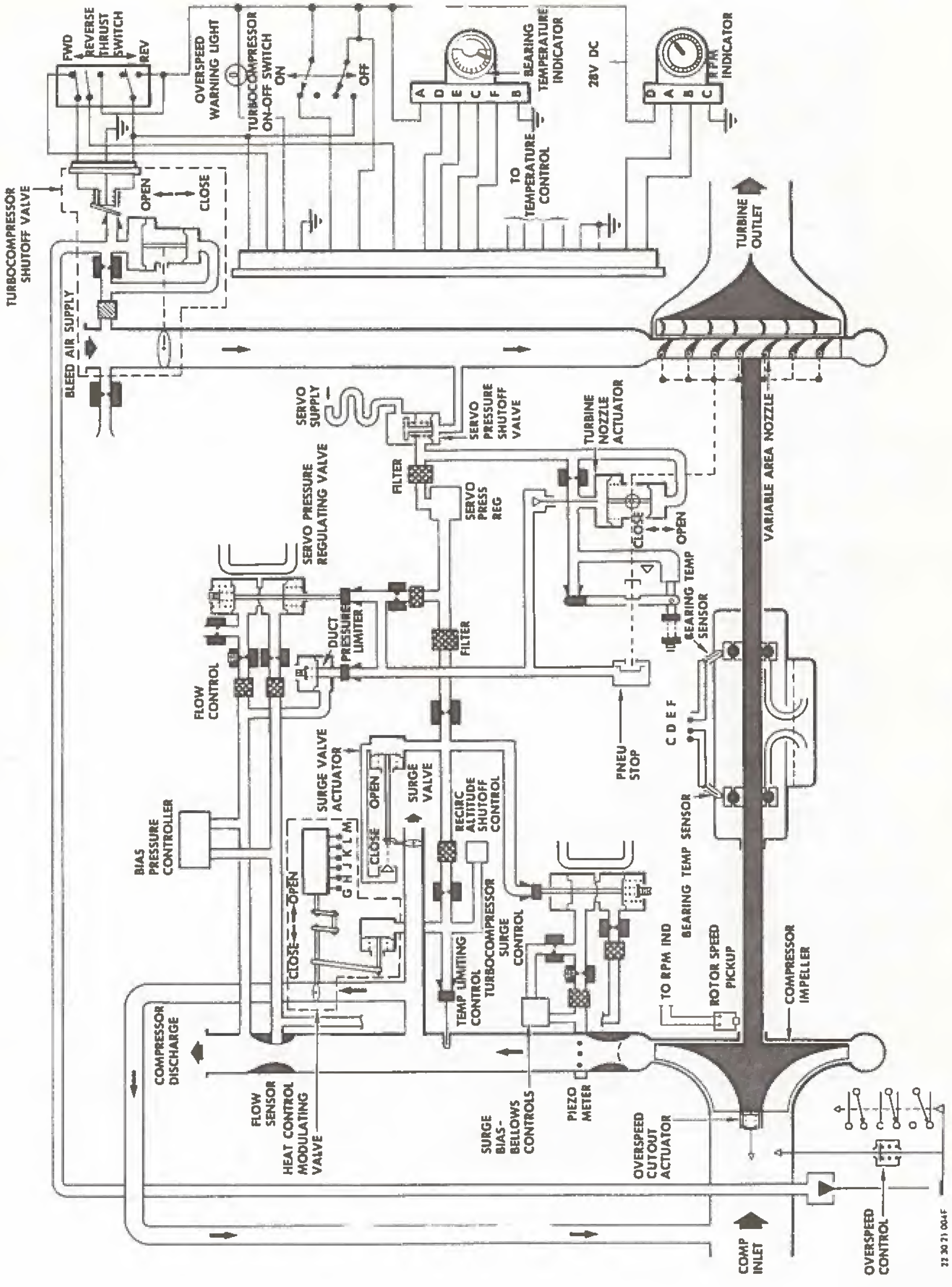


A BIAS PRESSURE CONTROL



22 02 21 1978

Bias Pressure Control
Figure 7



Turbocompressor Operational Schematic
Figure 8

B. Turbocompressor Output.

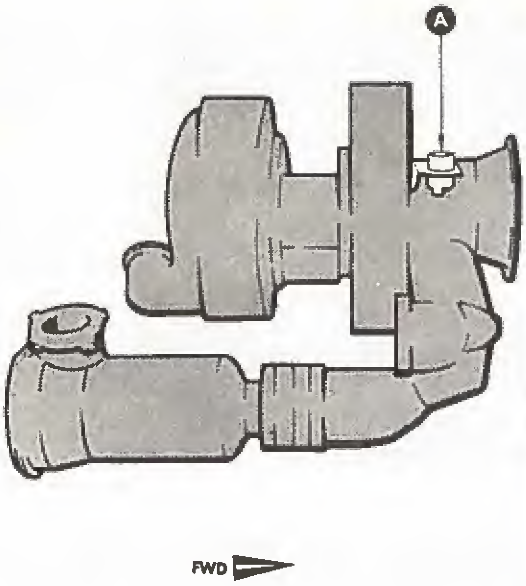
Turbocompressor output, illustrated in Figure 9, is controlled by vanes in the variable area turbine nozzles. Reducing the nozzle area through which the bleed air passes reduces rotor rpm by a reduction in input energy to the turbine rotor. Change in nozzle area is accomplished by sensing turbocompressor output flow and outlet pressure. The flow control senses turbocompressor output flow from signals picked up at the venturi which are subject to biasing by the bias pressure control. A reduction in weight flow below normal requirements will move the flow control poppet toward its seat thereby increasing amplifier pressure in the nozzle actuator. Increased pressure in the amplifier increases pressure at the large diaphragm of the nozzle actuator which causes the actuator to move toward the "open" position. The nozzle actuator moves the turbine nozzle vanes to increase the nozzle area and thus increase weight flow. The pressure limiter control senses turbocompressor outlet pressure. When outlet pressure approaches the preset limit, the control poppet moves away from its seat thus decreasing amplifier pressure in the nozzle actuator. The nozzle actuator moves the turbine nozzle vanes to decrease the nozzle area and thus decrease output weight flow.

C. Compression Heating.

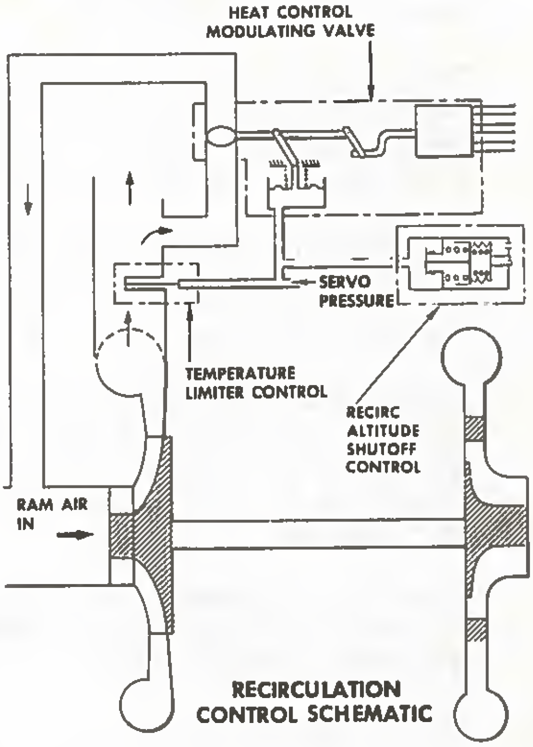
When an increase in air temperature is called for, compressor discharge air may be heated by recirculation through the compressor. The heat control modulating valve will permit recirculation of compressor discharge air when the valve is open. The heat control modulating valve is opened by a signal from the electronic temperature control which causes the valve electric actuator to rotate to permit servo pressure in the valve pneumatic actuator to open the valve. Should recirculated air temperature reach a preset maximum, the temperature limiter control closes the valve by releasing the valve servo pressure. When the airplane climbs above 12,000 feet, additional heating of the air by recirculation through the compressor is no longer required and the heat control modulating valve is held closed by venting the servo pressure at the recirculation altitude shutoff control.

D. Compessor Surge.

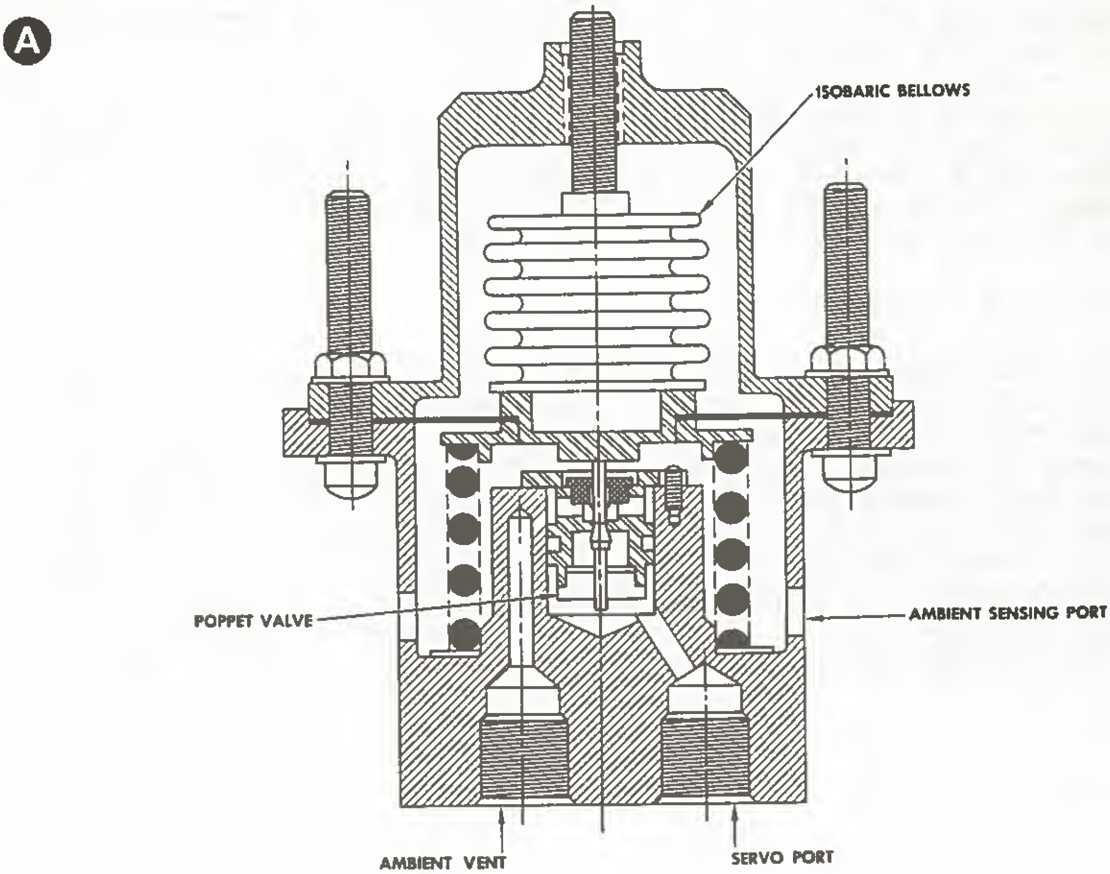
Compressor surge is a rapid fluctuation of compressor RPM caused by a reduction in weight flow of compressor discharge air. To control compressor surge the turbocompressor incorporates a surge valve and a surge control. The surge control senses output flow from signals picked up at the venturi and piezometer. The piezometer signal is subject to control by the bias altitude control. Whenever the pressure differential decreases below a set schedule, the surge control poppet unseats and opens the surge valve by venting the valve servo pressure. The open surge valve provides a direct exhaust for the compressor discharge air into the plenum chamber when the turbocompressor approaches surge conditions.



TURBOCOMPRESSOR



RECIRCULATION CONTROL SCHEMATIC



RECIRCULATION ALTITUDE SHUTOFF CONTROL

Recirculation Altitude Shutoff Control
Figure 9

E. Turbocompressor Indicators.

Indications of internal turbocompressor operation are obtained through bearing temperature probes, rotor speed pickup, and overspeed control. These units are connected to indicators on the flight engineer's control panel and are illustrated on Figure 10.

The bearing temperature probes sense the temperature of their respective bearings and the temperature of the warmest bearing is read on the temperature indicator. Refer to 21-1-8, TURBOCOMPRESSOR BEARING TEMPERATURE INDICATOR for further details.

A rotor speed pickup converts magnetic impulses induced by lugs on the rotating seal into electrical pulsations which are translated into rotor rpm by the rpm indicator and control located on the flight engineer's control panel. Refer to 21-1-9, TURBOCOMPRESSOR RPM INDICATOR for further details.

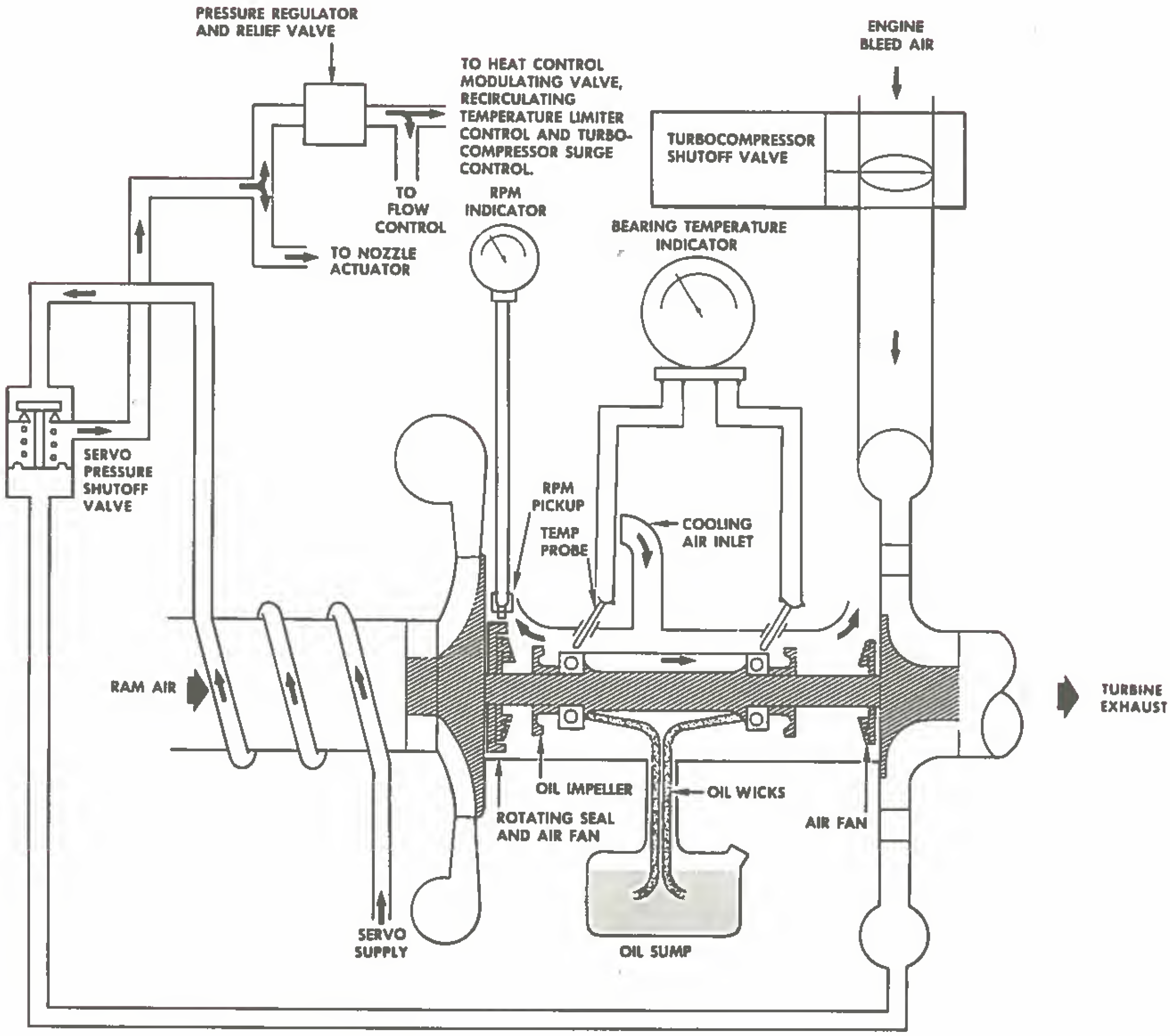
When the turbocompressor overspeeds, the overspeed switch closes a circuit which illuminates an OVERSPEED TRIP warning light on the flight engineer's control panel.

F. Servo Pressure Source.

Engine bleed air is the source of servo pressure for operation of the pneumatically operated valves and controls of the turbocompressor. Servo pressure is tapped externally from the bleed air supply ducting and is cooled by passing through four loops around the compressor ram air inlet. The servo air is then available to the turbocompressor components when turbine pressure is great enough to open the servo pressure shutoff valve. The servo air is then filtered and kept below a preset pressure by the pressure regulator and relief valve.

G. Cooling and Lubrication.

The turbocompressor assembly incorporates air cooling and oil lubrication units to cool and lubricate the rotor shaft bearings. Two flexible ducts directed toward the compressor inlet end of the assembly serve as bearing cooling air inlets. The cooling air is pulled in over the inner bearing housing by air fans on the rotor and impeller ends of the rotative assembly and discharged along the inner turbine housing. The bearings are lubricated by oil wicks fed from the oil sump. The oil is deposited on both ends of a flared spacer which is mounted between the bearings. The oil is thrown outward from the flared spacers and is drawn through the bearings by the pumping action of the oil impellers.



22 30 21 051C

Turbocompressor Lubrication,
Cooling and Servo Pressure Schematic
Figure 10

TURBOCOMPRESSOR ASSEMBLY - MAINTENANCE PRACTICES

1. Servicing

A. Turbocompressor.

(1) Open turbocompressor access doors on lower surface of the fuselage.

(2) Check sight line level gage in the turbocompressor oil sump. If oil level is above the sight line, the sump contains a sufficient quantity of oil. If oil level is below the sight line, oil shall be added (refer to Chapter 12, SERVICING).

2. Removal/Installation Turbocompressor

A. General.

(1) During line maintenance, the following components can be removed for replacement or repair while the turbocompressor package is installed in the airplane:

(a) Heat recirculation temperature limiter (refer to 21-1-3, Maintenance Practices).

(b) Turbocompressor surge valve (refer to 21-1-4, Maintenance Practices).

(c) Venturi duct (refer to 21-1-10, Maintenance Practices).

(2) The turbocompressor package must be removed from the airplane for quick replacement of the following components (refer to maintenance practices of specific component).

(a) Bias altitude control (refer to 21-1-7, Maintenance Practices).

(b) Heat control modulating valve (refer to 21-1-2, Maintenance Practices).

(c) Recirculation altitude shutoff control (refer to 21-1-6, Maintenance Practices).

(d) Turbocompressor bearing temperature probes (refer to 21-1-8, Maintenance Practices).

(e) Turbocompressor RPM probe (refer to 21-1-9, Maintenance Practices).

(f) Pressure regulator and relief valve (refer to 21-1-5, Maintenance Practices).

(g) Servo pressure shutoff valve.

(3) The following components should be replaced only at an overhaul activity.

(a) Turbocompressor nozzle actuator.

(b) Turbocompressor flow control.

(c) Turbocompressor surge control.

(d) Overspeed cutout actuator.

(e) Turbocompressor overspeed control.

(f) Bias pressure control.

(g) Pressure limiter control.

B. Equipment Required.

A small table which can be raised or lowered to support the turbocompressor during removal and installation is recommended. The table must be small enough to allow access to the turbocompressor frame mounting bolts when it is in position under the turbocompressor. Without the table, at least two men are required to raise and lower the turbocompressor package. The turbocompressor package weighs approximately 100 pounds.

C. Preparation.

(1) Open the following circuit breakers.

(a) TURBO COMPR ON (cabin or flight deck).

(b) TURBO COMPR OFF (cabin or flight deck).

(c) TURBO COMPR IND (cabin or flight deck).

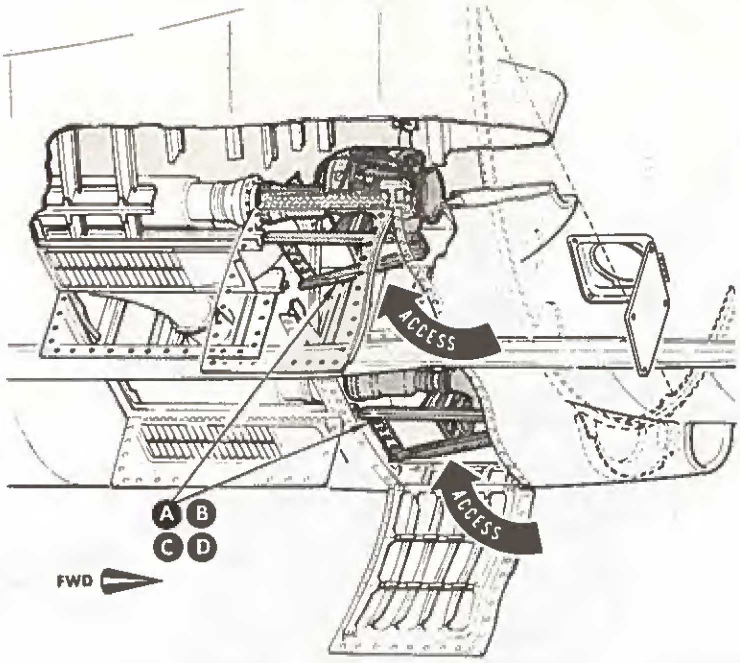
(2) Open turbocompressor access door (cabin or flight compartment).

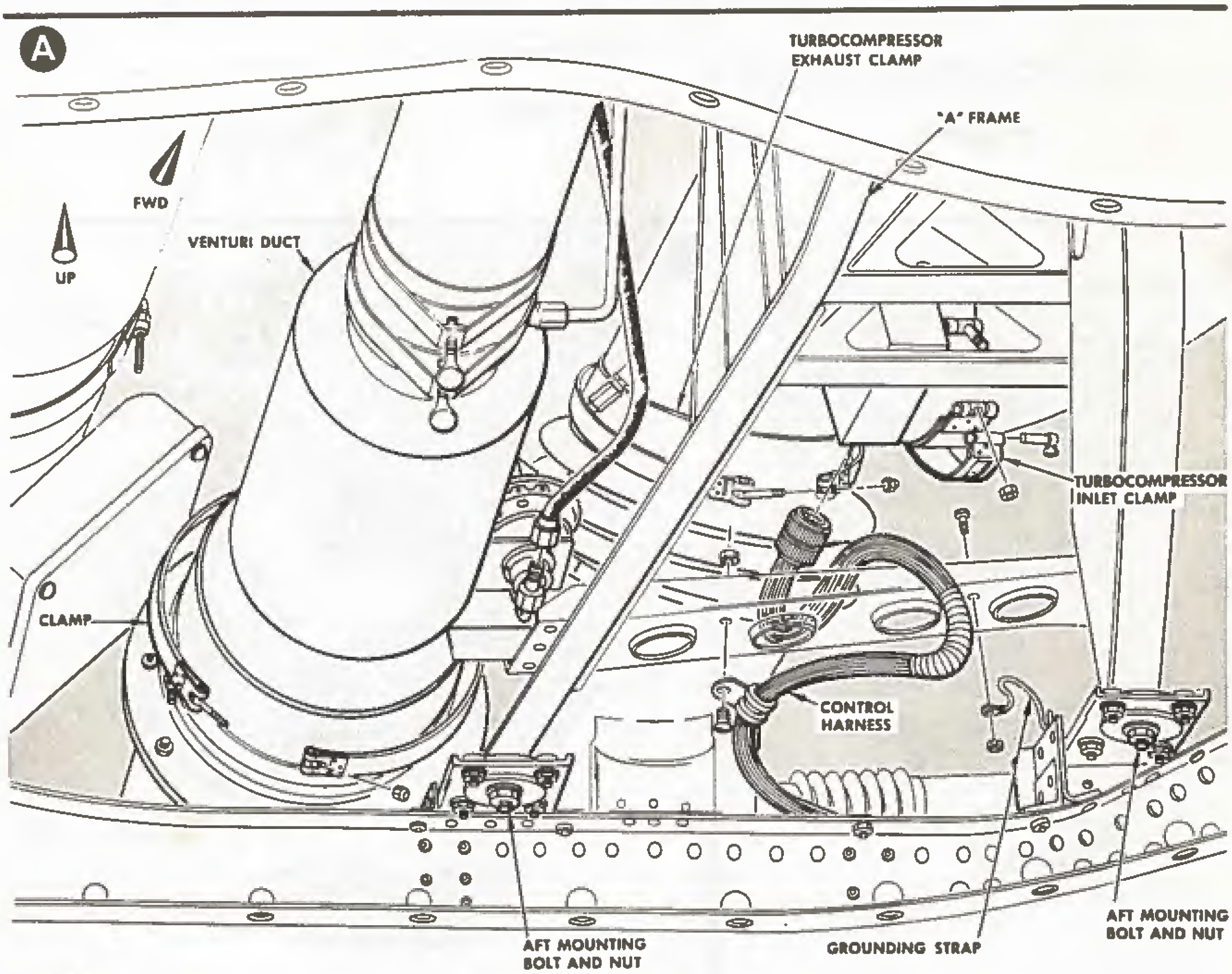
NOTE: Step (3) is necessary only when removing the flight deck turbocompressor.

(3) Remove venturi duct and surge valve from turbocompressor as a unit (refer to Removal/Installation Venturi Duct).

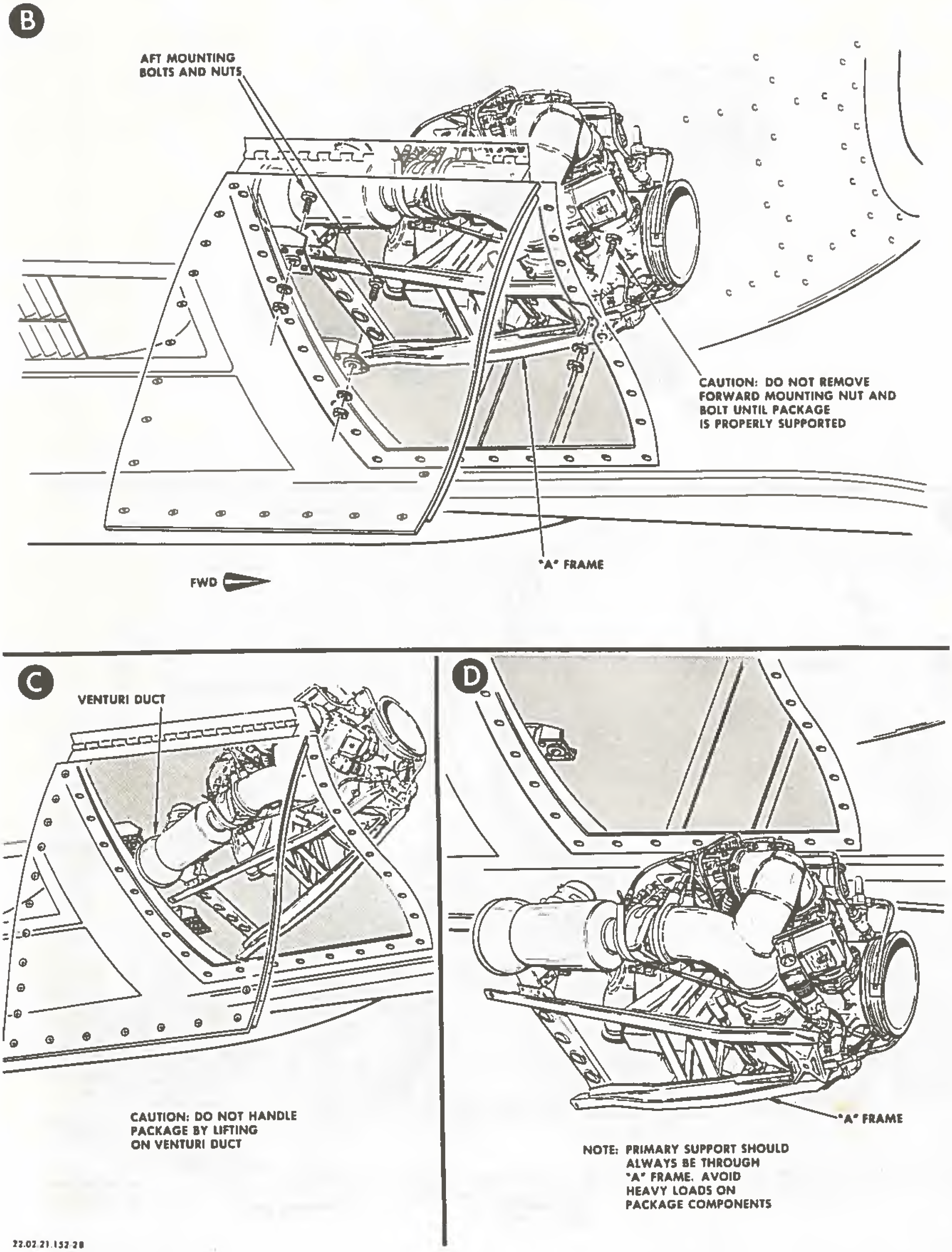
(4) Prior to removing turbocompressor, drain oil from turbocompressor sump (refer to Chapter 12, SERVICING).

	Figure Detail
D. Remove Turbocompressor Package (see Figure 201).	
NOTE: Step (1) is necessary only when removing the cabin (right) turbocompressor.	
(1) Disconnect clamp at aft end of venturi duct.	A





Turbocompressor Package Installation
Figure 201 (Sheet 1 of 2)



22.02.21.152-28

Turbocompressor Package Installation
Figure 201 (Sheet 2 of 2)

	Figure Detail
(2) Disconnect package control harness at receptacle under turbine exhaust and remove clamp which secures harness to A frame. (Cap receptacle and connector.)	A
(3) Disconnect turbine inlet clamp.	A
(4) Disconnect turbine exhaust duct clamps and remove duct.	A
(5) Disconnect bleed air shutoff valve line from overspeed control port 33, and servo supply tube at cooling coil connection. (Tag each line for installation.) (Cap ports and tubing.)	
(6) Disconnect grounding strap from A frame (near left hand mounting point).	A
(7) Remove two nuts, washers and bolts from aft mounting points of turbocompressor A frame.	B
CAUTION: DO NOT REMOVE THE SINGLE FORWARD MOUNTING BOLT UNTIL THE PACKAGE IS PROPERLY SUPPORTED.	
(8) Support turbocompressor A frame with a table, or by having two men support the package.	
CAUTION: USE CARE TO HANDLE TURBOCOMPRESSOR PACKAGE BY A FRAME OR MAIN TURBO HOUSINGS ONLY. DO NOT USE VENTURI DUCT OR OTHER COMPONENTS AS HAND GRIPS.	
(9) Remove forward A frame mounting bolt, then move turbocompressor aft and slightly upward.	B
(10) Shift turbocompressor and raise forward mounting point of A frame above forward support bracket.	
(11) Move turbocompressor forward and slightly left and above forward support bracket.	
(12) Lower aft end of turbocompressor through access door and remove turbocompressor from airplane.	C,D
NOTE: The A frame is not a part of the turbocompressor package, but is normally left attached to provide a convenient supporting base.	
(13) When required, separate mounting frame from compressor by removing two screws and nuts that secure venturi duct to frame (if not previously removed), then remove four mounting bolts which secure package to frame.	

	Figure Detail
E. Install Turbocompressor Package.	
CAUTION: USE CARE TO HANDLE TURBOCOMPRESSOR PACKAGE BY A FRAME OR MAIN TURBO HOUSINGS ONLY. DO NOT USE VENTURI DUCT OR OTHER COMPONENTS AS HAND GRIPS.	
(1) When required, attach turbocompressor to A frame with four mounting bolts. Attach venturi duct bracket to A frame with two screws and nuts.	
(2) Raise forward end of turbocompressor into forward area of turbocompressor compartment above and slightly left of forward support bracket.	C
(3) Raise aft end of turbocompressor until aft mounting points of A frame are above aft support brackets in airplane. Move turbocompressor aft until forward mounting point of A frame can be lowered below forward support bracket. Secure forward mounting point with bolt, washer and nut.	B
NOTE: Slight shifting may be necessary for alignment of all three mounting points.	
(4) Install two bolts, washers, and nuts to secure the two aft connections of the A frame.	A
(5) Attach electrical grounding strap near left-hand mounting point of A frame.	A
(6) Connect bleed air shutoff valve vent line to overspeed control port, and connect servo supply line to cooling coil inlet. Tighten coupling nuts 1/6 to 1/3 turns beyond point of initial torque rise.	
(7) Position and connect bleed air inlet duct to turbine inlet; secure with clamp.	A
(8) Install and connect turbine exhaust to discharge duct in airplane; secure with clamp.	A
(9) For flight duct turbocompressor only, install venturi duct and surge valve (refer to Removal/Installation Venturi Duct).	
(10) For cabin turbocompressor only, position hose to connect aft end of venturi duct to air conditioning system duct; secure with clamp.	A

Figure Detail

(11) Connect control harness to electrical receptacle under turbine scroll, and install clamp to secure harness to A frame. A

(12) Add oil to turbocompressor sump (refer to Chapter 12, SERVICING).

(13) Close TURBO COMPR ON, TURBO COMPR OFF, and TURBO COMPR IND circuit breakers.

(14) Perform operational check of turbocompressor (refer to 21-0, Maintenance Practices).

(15) Recheck duct clamps for security.

(16) With turbocompressor operating check three flexible servo lines, servo inlet fitting, and overspeed cutout fitting for leaks.

(17) Close turbocompressor access doors.

3. Adjustment/Test

A. Turbocompressor Package - Leakage Test.

(1) Apply 12 psig pressure to servo inlet.

(2) Apply Leak-Tec or equivalent to all servo tube connections and detect leaks by observing bubble formation.

NOTE: Leak-Tec is manufactured by American Gas and Chemicals Inc., New York, N.Y.

(3) When leakage occurs at couplings, back off the coupling nut(s) and examine nut, sleeve and tubing for burrs, metal chips, nicks or cracks. Remove burrs or chips when present and tighten coupling nut 1/6 to 1/3 turns beyond point of initial torque rise. Nicked or cracked parts necessitate replacement of the entire tubing assembly.

NOTE: Leakage from control poppets is permissable. Open servo ports may be capped when required to build up servo line pressure.

4. Inspection/Check

A. Maintenance Check.

(1) Examine package mounting bracket on venturi duct for bends or cracks.

(2) Check four frame mounting bolts for tightness.

(3) Examine all clamps for tightness and signs of cracks or corrosion.

(4) Check all servo tubing for sharp bends or cracks that might impair servo pressure supply.

(5) Examine electrical harness for damaged insulation on wires. Check receptacle connections for tightness.

(6) Examine bleed air and ram air ducts for dents, scratches, cracks or internal obstruction.

(7) Manually rotate turbocompressor rotor, checking for obvious noise or resistance to rotation.

5. Cleaning/Painting

A. Clean Turbocompressor Assembly.

(1) Clean exterior surfaces with solvent, Specification AMS 3160A, to remove any dirt or oil deposits.

WARNING: EXERCISE CARE TO INSURE THAT NO SOLVENT ENTERS THE DIAPHRAGM CHAMBER OF CONTROLS OR CABIN AIR PORTS OF THE PACKAGE. APPLY SOLVENT WITH A SOFT LINTLESS CLOTH MOISTENED WITH SOLVENT USING A MINIMUM AMOUNT OF CLEANER ON ELECTRICAL PARTS.

(2) Remove corrosion with steel wool or crocus cloth.

B. Paint Turbocompressor Assembly.

(1) Touch up worn or damaged painted surfaces when the extent of damage does not exceed approximately 5 percent of the total painted surface.

(2) Mask all areas that do not require painting (ports, plated areas or identification) but are near the damaged areas.

(3) Use Sicon 7X938 black enamel or equivalent on all parts subject to high temperatures, such as the bleed air shutoff valve body and turbine housing. Thin paint with toluol, Specification AMS 3180B, using seven parts paint to one part toluol.

NOTE: Sicon is obtainable from Midland Industrial Finishes, Waukegan, Illinois.

(4) Use one coat of glyceryl phthalate black enamel, Specification AMS 3120B, without primer for compressor housings, overspeed control housing, cabin heat control valve body, surge valve body, venturi duct, temperature limiter control or transition outlet duct.

(5) Use one coat of zinc chromate primer, Specification AMS 3110C, and two coats of black enamel, Specification AMS 3120B, on all other painted parts.

(a) Apply primer smoothly to obtain an even semi-transparent greenish yellow surface.

(b) Before painting, allow primer to air dry 30 minutes minimum at room temperature.

(6) Allow each topcoat application to air dry at room temperature for four hours.

TURBOCOMPRESSOR SHUTOFF VALVE - DESCRIPTION AND OPERATION

1. Description

The turbocompressor shutoff valve provides the means for turning the turbocompressor on or off by either permitting or interrupting engine bleed air to the turbine section of the turbocompressor. The shutoff valve, illustrated on Figure 1, consists of a housing, a butterfly valve, a pneumatic actuator, and an electric solenoid. The butterfly valve is mechanically linked to the actuator shaft which in turn connects to two differential pistons in dual chambers. Servo passageways connect both actuator chambers to a servo tap in the valve bore upstream from the butterfly. The servo passageway on the large piston side of the orifice has two vents. One vent is ducted to the overspeed control which keeps the vent closed except in an overspeed condition. The second vent is closed by the solenoid which is a part of the valve and is mounted on the actuator. The solenoid is wired to a switch in the overspeed control and connects externally to the reverse thrust relay, a landing gear ground safety relay, and the turbocompressor ON-OFF switches.

2. Operation

A. Valve Opening.

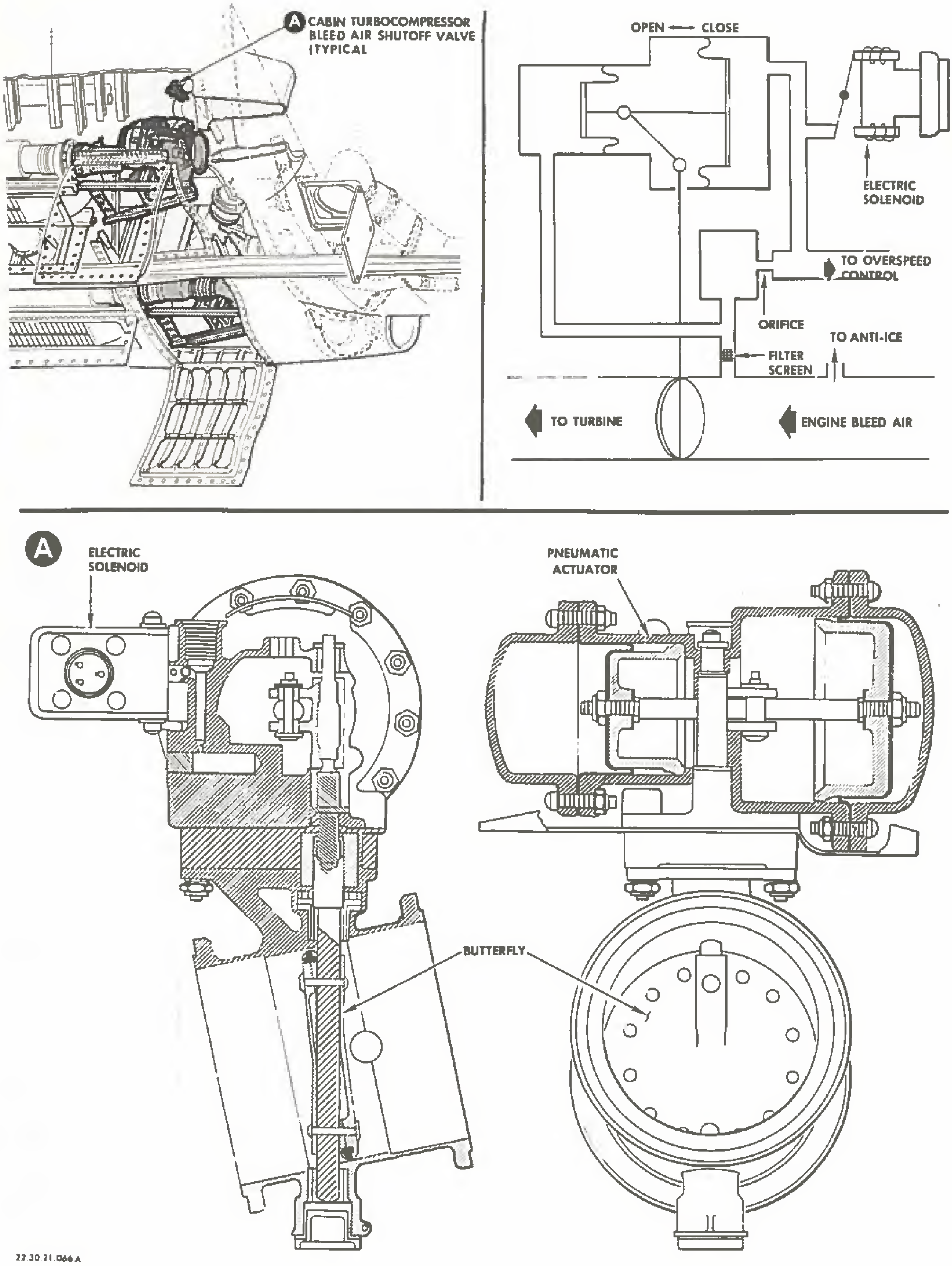
Valve operation can be ascertained by following the schematic illustrated on Figure 1. Engine bleed air pressure is applied through a filter screen and passageways to both actuator chambers to open the valve. Pressure on the larger diaphragm creates a greater total force than that created on the smaller diaphragm causing the actuator pistons to move toward the small actuator chamber. This movement opens the butterfly valve allowing engine bleed air to pass to and drive the turbocompressor.

B. Valve Closing.

When the air pressure in the servo passageway to the large actuator chamber is vented by either the overspeed control poppet valve or the shutoff valve solenoid, the shutoff valve closes. The air pressure in the smaller actuator chamber, due to restriction of the orifice, will maintain a greater pressure on the small diaphragm when the large chamber is vented, causing the actuator pistons to move toward the large actuator chamber and close the valve.

C. Electric Solenoid.

The electric solenoid contains an "on" winding and an "off" winding both connected to a common ground. When 28-volt dc power is applied to the "on" winding through the closed contacts of the turbocompressor ON-OFF switch, overspeed control, reverse thrust switches and sequencing device, the solenoid snaps a poppet into position over the servo passage vent and the shutoff valve opens. When the switch in the overspeed control trips, or the reverse thrust switch moves to "reverse", or the turbocompressor ON-OFF switch is moved to OFF, the circuit to the



Turbocompressor Shutoff Valve
Figure 1

solenoid "on" winding is broken and 28-volt dc power is supplied to the solenoid "off" winding. Energizing the solenoid "off" winding unseats the solenoid poppet which vents the servo pressure and closes the shutoff valve. When the shutoff valve closes the turbocompressor shuts down. The use of two windings prevents loss of the turbocompressor operation upon any loss of electrical power. To change the valve position the 28-volt dc signal must be removed from one winding and applied to the other. Thus loss of electrical power to the energized winding will not change valve position.

TURBOCOMPRESSOR SHUTOFF VALVE - MAINTENANCE PRACTICES

1. Removal/Installation Turbocompressor Shutoff Valve (see Figure 201)

A. Remove Turbocompressor Shutoff Valve.

(1) Remove turbocompressor package (refer to 21-1-0, Maintenance Practices).

(2) Disconnect electrical connector from solenoid receptacle.

(3) Disconnect overspeed vent line from valve port 30. (Tag for installation.) (Cap tube ends.)

(4) Remove lock pins from duct clamps at each end of valve and remove duct clamps. Remove gaskets from each end of valve and remove valve.

B. Install Turbocompressor Shutoff Valve.

(1) Position shutoff valve between open ends of bleed air duct.

CAUTION: BE SURE THE CAST ARROW ON THE VALVE POINTS DOWNSTREAM TOWARD THE TURBINE INLET OF THE TURBOCOMPRESSOR.

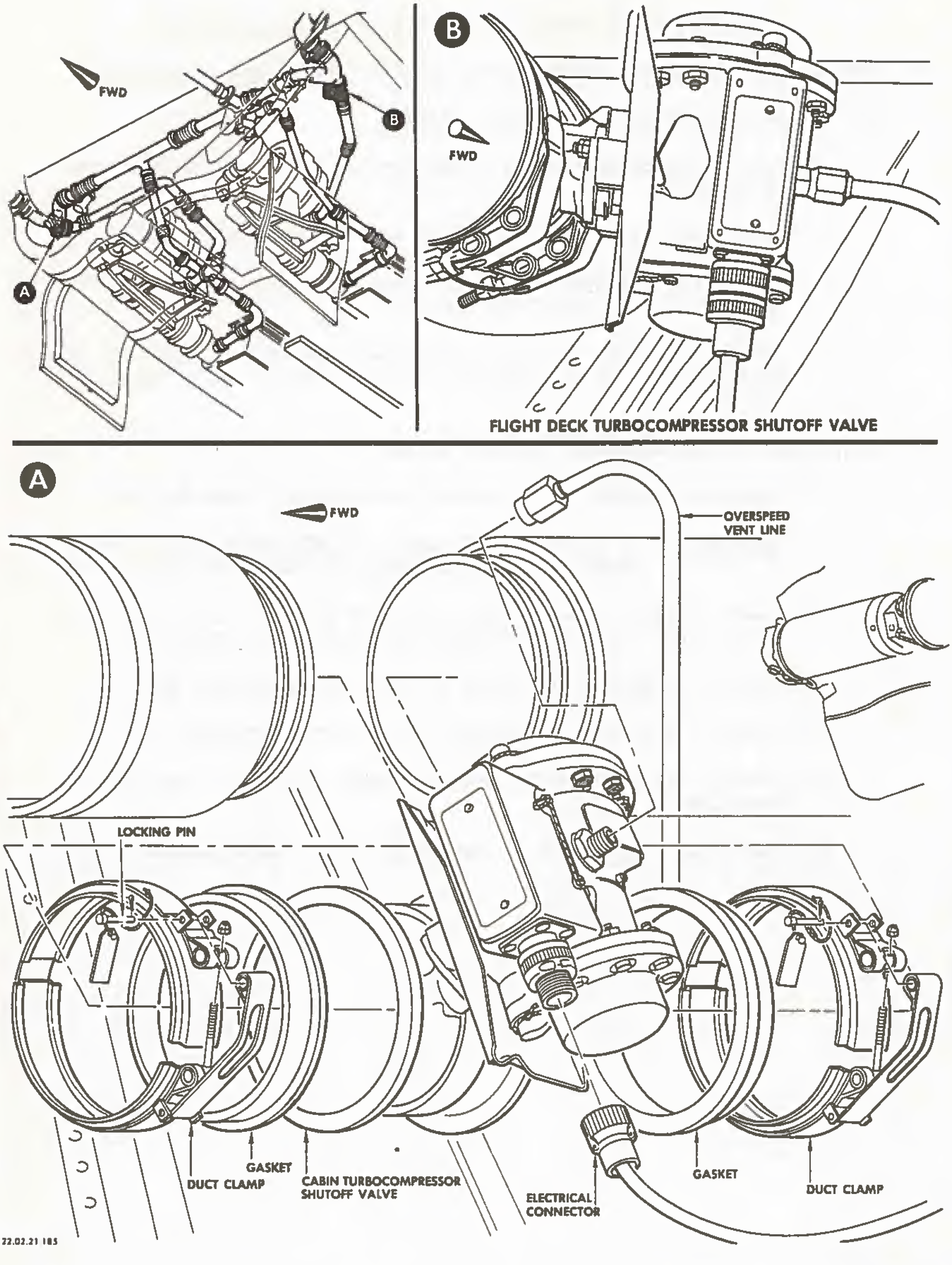
(2) Insert gaskets between valve and duct at each end of valve and secure with duct clamps (refer to Chapter 36, PNEUMATICS).

(3) Connect overspeed vent line to valve actuator port 30.

(4) Connect electrical connector to solenoid receptacle.

(5) Install turbocompressor package (refer to 21-1-0, Maintenance Practices).

(6) Check valve operation by operating the turbocompressor.



Turbocompressor Shutoff Valve Installation
Figure 201

HEAT CONTROL MODULATING VALVE - DESCRIPTION AND OPERATION

1. Description

The heat control modulating valve, illustrated on Figure 1, consists of a pneumatic actuator, an electric actuator, and a butterfly valve. The pneumatic actuator consists of an actuator housing with six ambient vents, an actuator shaft, a spring-loaded piston secured to the shaft, and a diaphragm which separates the piston from the actuator chamber in the cap. The electric actuator consists of an electric motor, gear train, and a positioning potentiometer.

The pneumatic actuator shaft is pinned to a slotted cam through a cam roller. The slotted cam is splined to the valve shaft which extends through the support mounting flange of the pneumatic actuator. The electric actuator is splined to a drive lever which holds an override cam against the pneumatic actuator cam on the valve shaft.

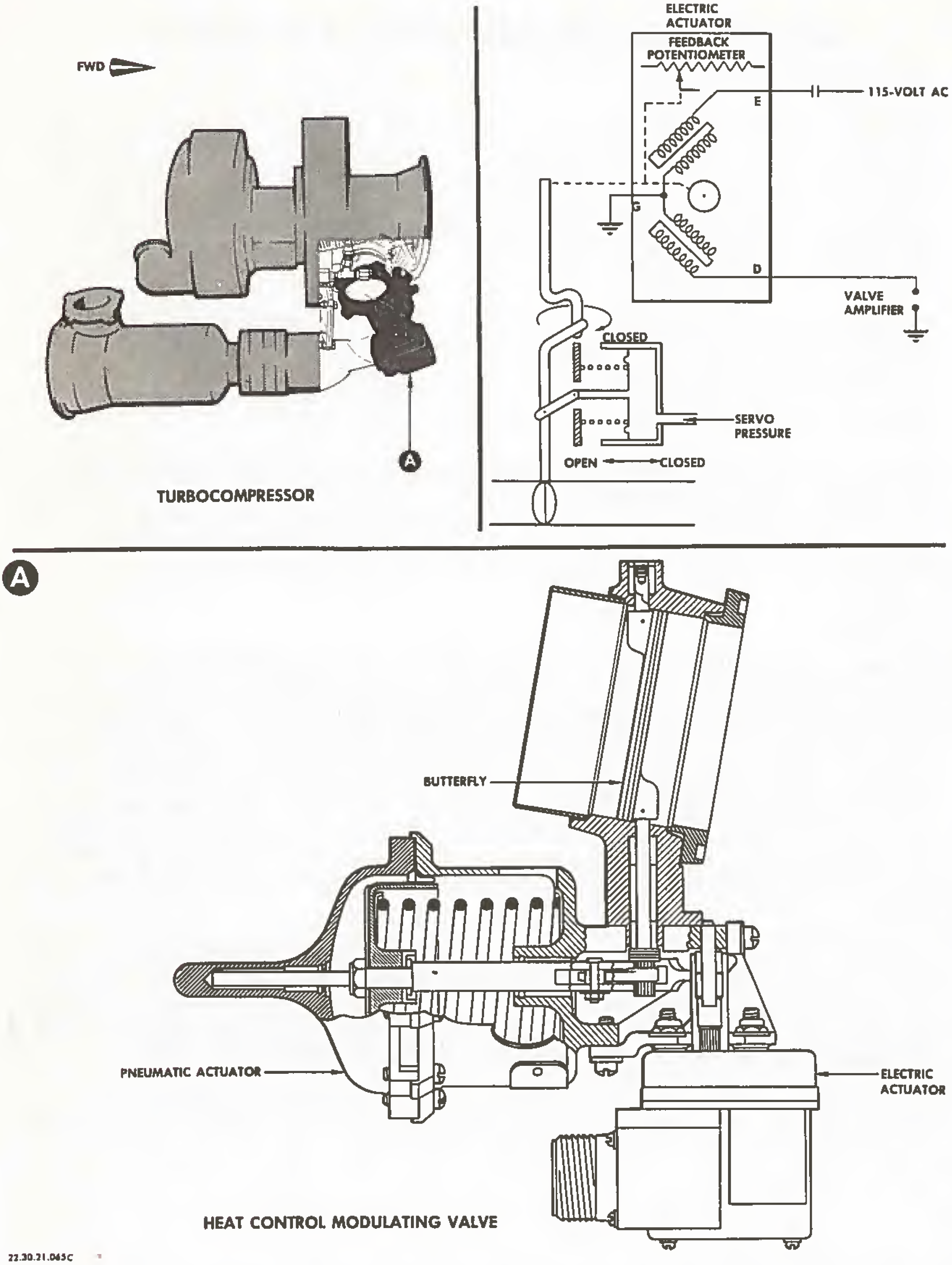
A line connects the pneumatic actuator chamber to the servo line between the surge control and pressure regulator. A tee in the servo line connects into the temperature limiter control. The heat control modulating valve is held in the normally closed position by the spring load on the actuator piston.

2. Operation

The heat control modulating valve operations can be ascertained by following the schematic on Figure 1. The valve controls the flow of recirculation air through the bypass return to the compressor inlet. Servo pressure supplied to the pneumatic actuator works against the spring load to open the valve. The servo pressure against the diaphragm causes the piston to move. This piston movement is translated from directional movement of the actuator shaft to rotational movement of the valve shaft by the cam and cam roller. As the actuator shaft moves out from the actuator housing the cam is forced to turn by the cam roller moving in the cam slot. The extent of the cam turning is limited by the position of the electric actuator drive lever.

When the electric actuator is energized to the valve "closed" position its drive lever loads the outside of the cam forcing the valve closed against any control pressure in the pneumatic actuator. When the electric actuator is energized toward the valve "open" position the butterfly rotates toward the open position due to servo pressure in the pneumatic actuator.

The electric actuator is controlled by the temperature control system. Termination or interruption of voltage to the electric actuator will permit



Heat Control Modulating Valve
Figure 1

servo pressure to open the valve only if the actuator is in the open position. The electric actuator, by rotating the override cam, allows the pneumatic actuator to open the valve only as much as the override cam permits. Thus, the temperature control system modulates the valve during automatic operation.

A temperature limiting control which senses compressor outlet air temperature, operates a poppet valve to vent servo pressure to atmosphere at a preset compressor outlet air temperature. With the servo pressure vented, pressure is reduced at the diaphragm of the pneumatic actuator thus moving the butterfly towards the closed position even though the electric actuator is positioned to permit the butterfly in the open position.

HEAT CONTROL MODULATING VALVE - MAINTENANCE PRACTICES

1. Removal/Installation Heat Control Modulating Valve (see Figure 201)

   A. Remove Heat Control Modulating Valve.

      (1) Remove turbocompressor package (refer to 21-1-0, Maintenance Practices).

      (2) Loosen coupling nuts on valve servo tube and remove tube.

      (3) Remove safety wire and disconnect electrical harness from valve actuator.

      (4) Remove nuts and screws securing clamps on flexible hose between valve and turbocompressor inlet duct; remove clamps and shield plates.

      (5) Roll flexible hose toward turbocompressor inlet to free valve.

      (6) Remove valve retaining nuts, washers and screws from transition duct and valve flanges.

      (7) Remove valve with tube union, O-ring and flexible hose.

   B. Install Heat Control Modulating Valve.

      (1) Slide new flexible hose on duct leading to overspeed control. Place both clamps on flexible hose; do not secure screws on clamps at this time.

      (2) Install tube union with new O-ring on valve pneumatic actuator.

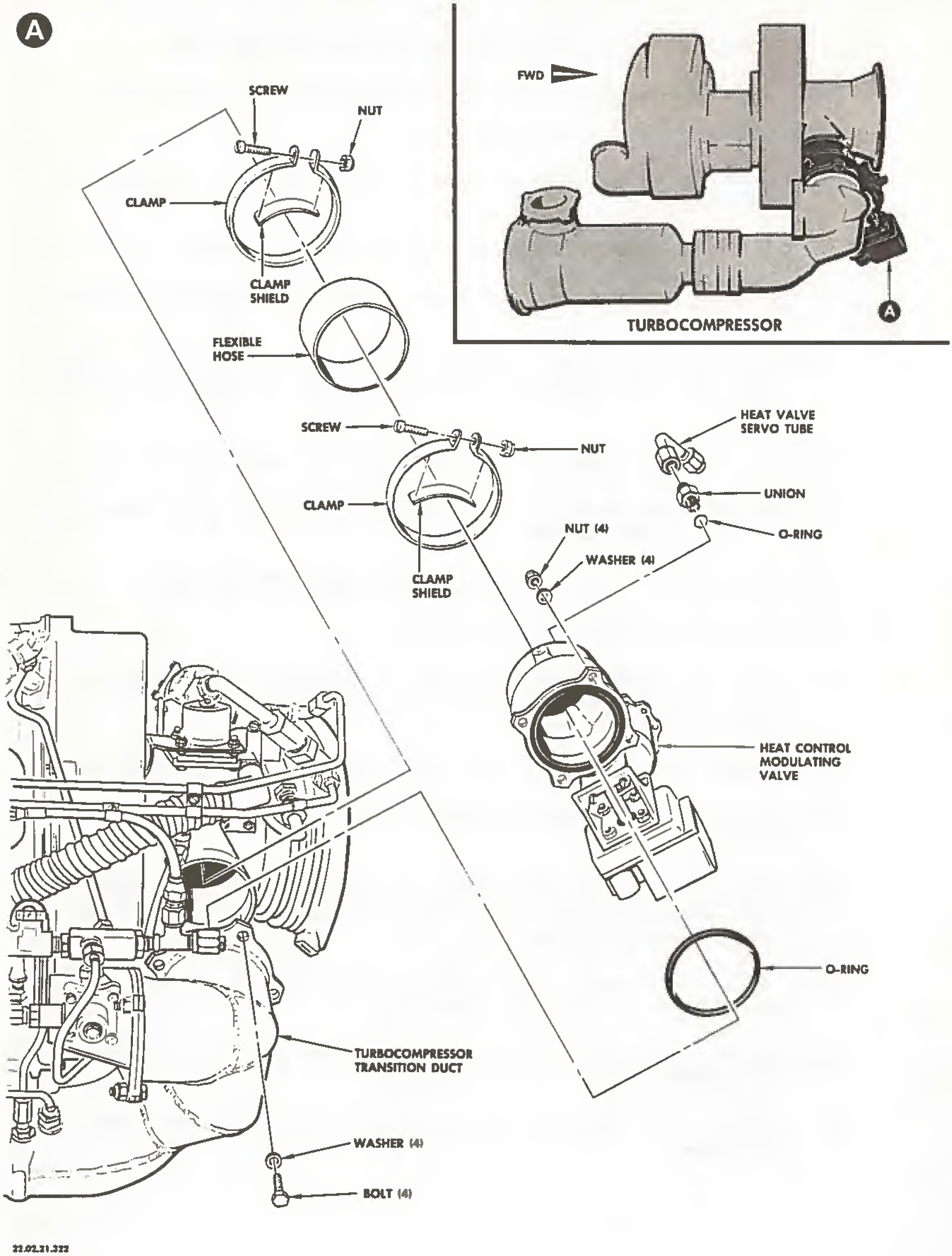
      (3) Position heat control modulating valve with new O-ring on transition duct flange.

      (4) Slide flexible hose onto valve and fasten with hose clamps. Ascertain clamp shields are installed under clamp separation before securing clamps.

      (5) Install valve servo tube; tighten coupling nuts 1/6 to 1/3 turn beyond point of initial torque rise.

      (6) Connect electrical harness to valve actuator; secure connection with safety wire.

      (7) Install turbocompressor package (refer to 21-1-0, Maintenance Practices).



Heat Control Modulating Valve Installation
Figure 201

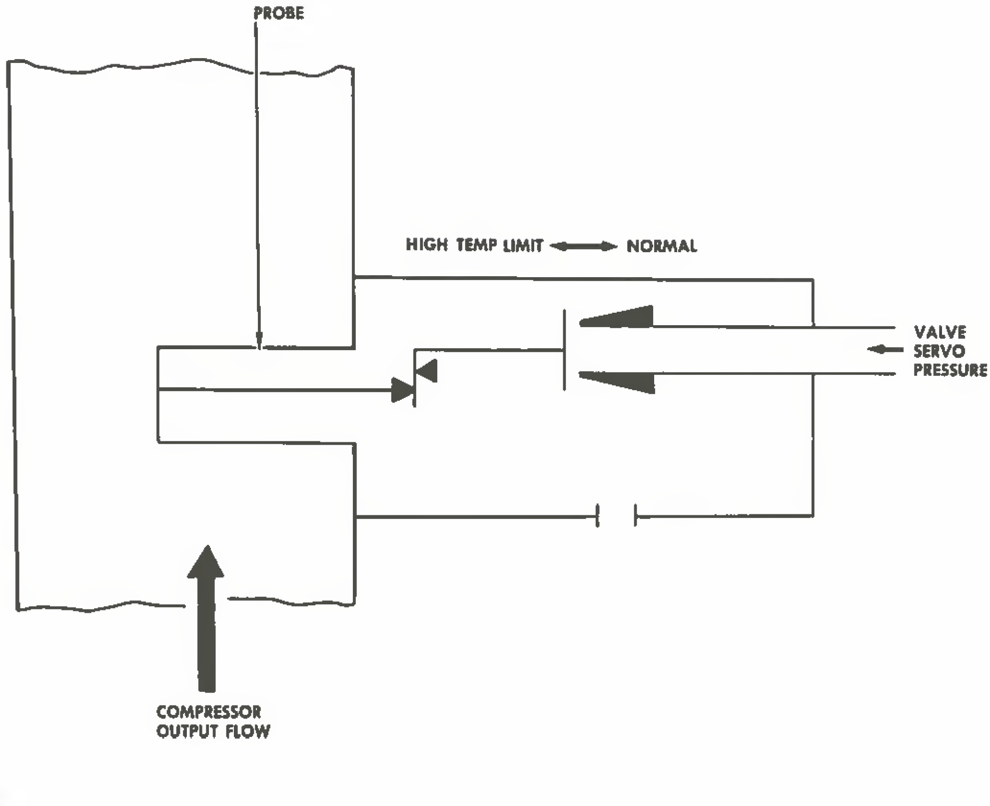
HEAT RECIRCULATION TEMPERATURE LIMITER CONTROL - DESCRIPTION AND OPERATION

1. Description

The temperature limiter control, illustrated on Figure 1, consists of a sensing probe and a poppet valve. The probe is placed in the transition outlet duct bore at a point between the compressor discharge port and the bypass port. A servo line connected to the limiter control, and closed by the control poppet, is connected into the servo line from the pressure regulator to the heat control modulating valve.

2. Operation

The control vents valve servo pressure to ambient when the temperature of the compressor discharge air exceeds a set level. Increases in the compressor discharge air temperature are sensed by an Invar rod in the probe which expands causing a rocker arm to open the poppet. The opening poppet permits servo air to escape, moving the heat control modulating valve toward the closed position thus limiting turbocompressor recirculation heating.



Heat Recirculation
Temperature Limiter Control Schematic
Figure 1

HEAT RECIRCULATION TEMPERATURE LIMITER CONTROL - MAINTENANCE PRACTICES

1. Removal/Installation Heat Recirculation Temperature Limiter Control (see Figure 201)

   A. Remove Heat Recirculation Temperature Limiter Control.

      (1) Loosen fitting and disconnect servo bleed air tube.

      (2) Remove safety wire and remove retaining screws from mounting flange. (Bag and tag screws for installation.)

      (3) Remove temperature limiter control and gasket.

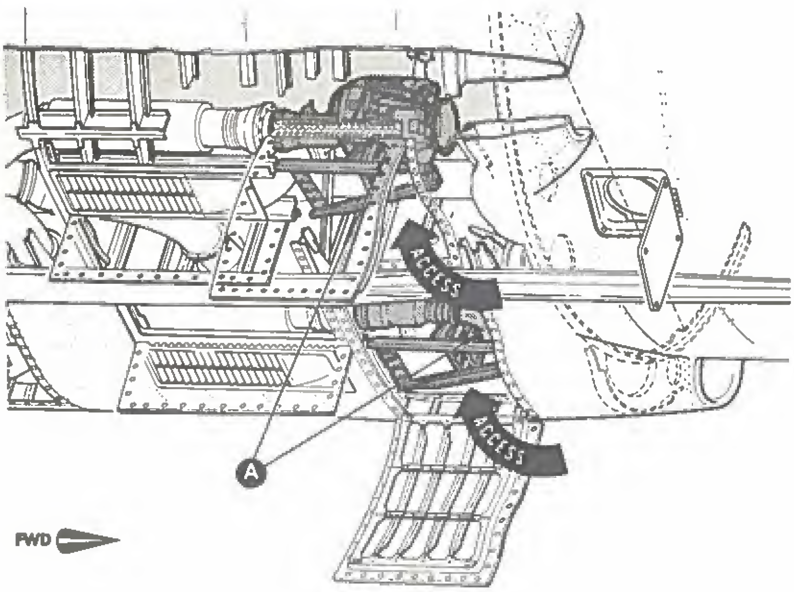
      CAUTION: INSTALL A PROTECTIVE SHIELD AROUND PROBE TO PREVENT DAMAGE.

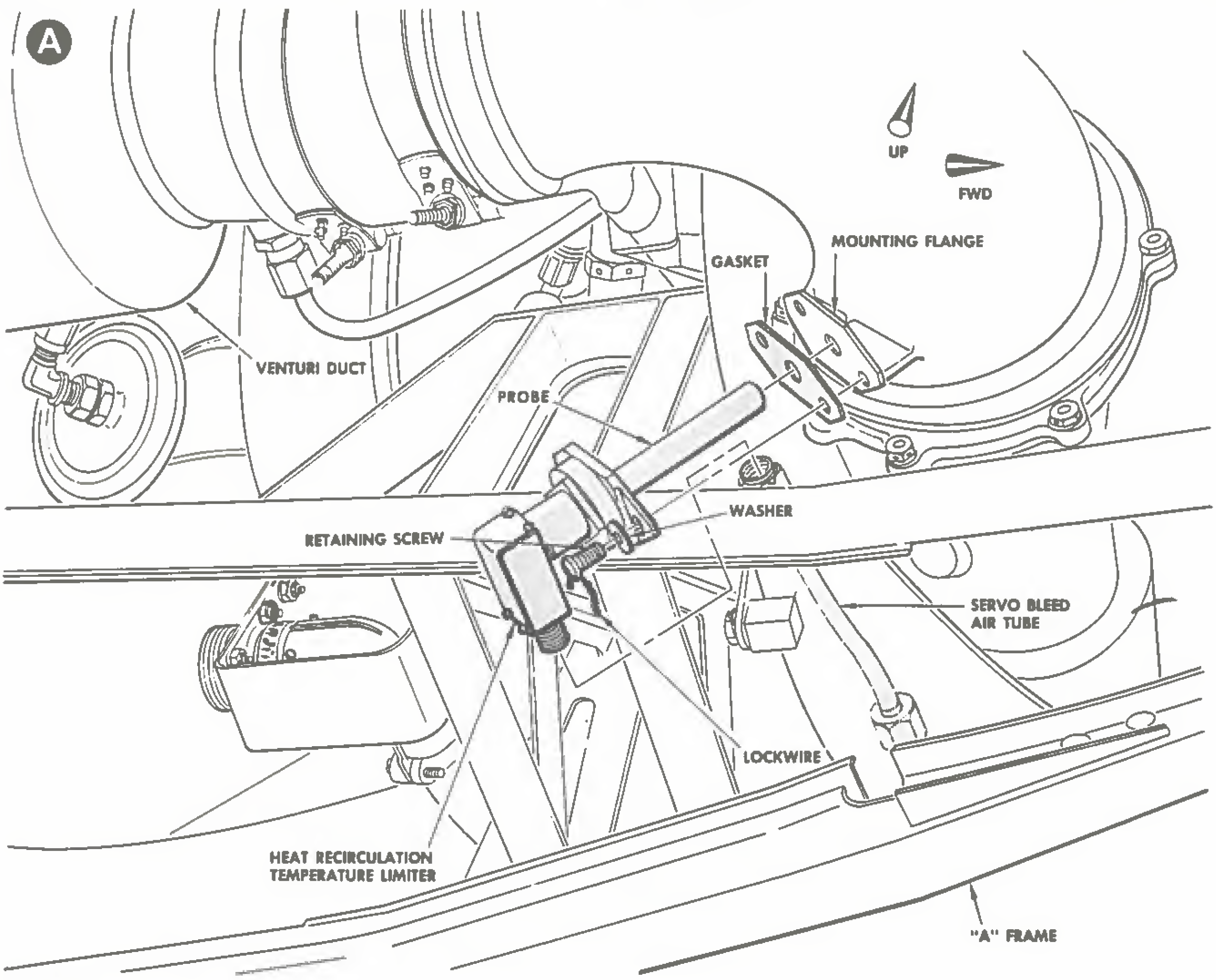
   B. Install Heat Recirculation Temperature Limiter Control.

      (1) Place temperature limiter control and gasket, probe end first, into compressor discharge duct.

      (2) Align mounting flange with holes in duct and install screws; secure screws with lockwire.

      (3) Connect servo bleed air tube.





Heat Recirculation
Temperature Limiter Control Installation
Figure 201

TURBOCOMPRESSOR SURGE VALVE - DESCRIPTION AND OPERATION

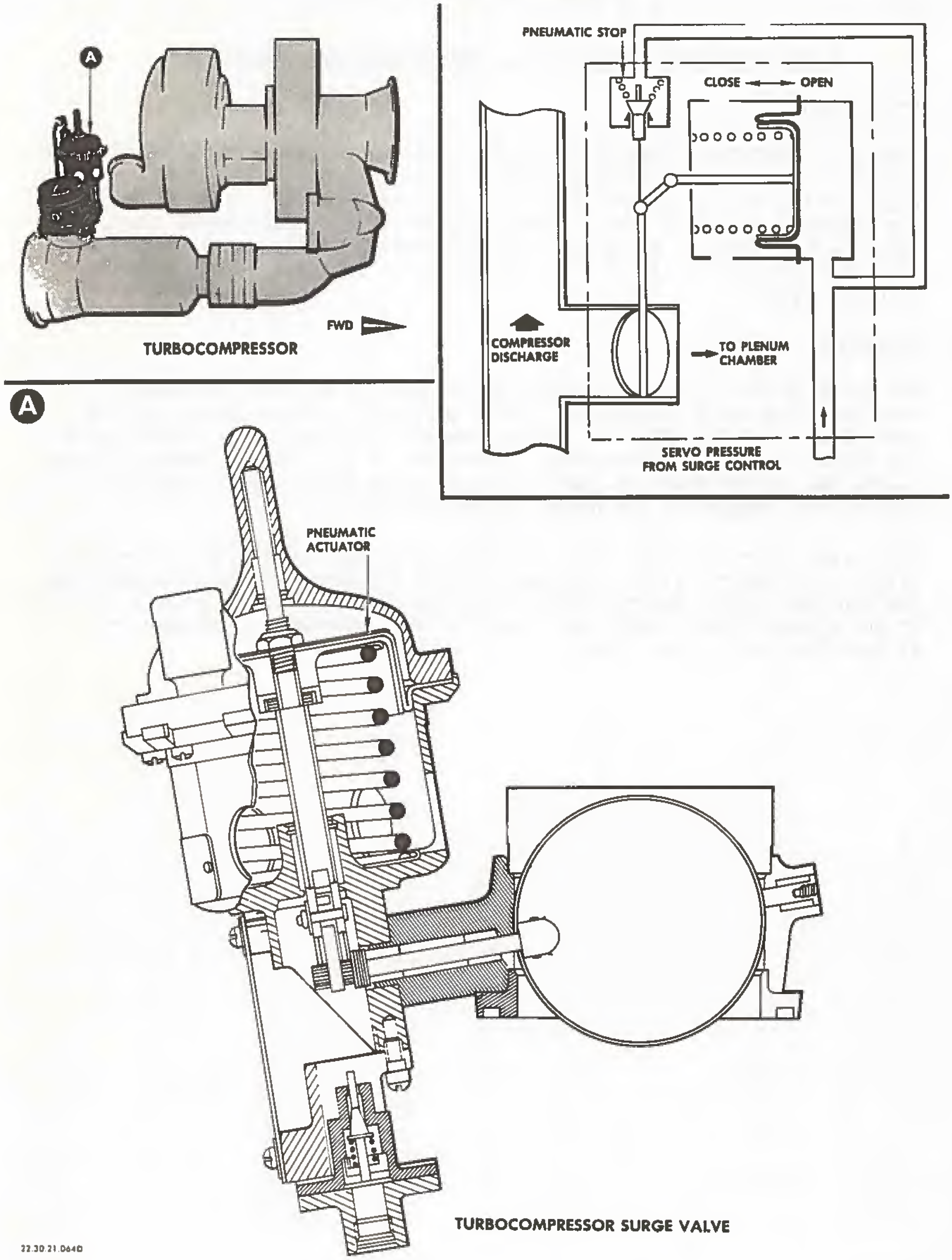
1. Description

The turbocompressor surge valve, shown on Figure 1, consists of a pneumatic actuator linked to a butterfly valve. A servo pressure line connects a poppet valve and the surge valve actuator chamber to the surge control. The diaphragm operated piston within the valve is spring-loaded toward the valve open position. The poppet valve is spring-loaded in the closed position and is mounted with its actuating pin in line with the surge valve actuator shaft.

2. Operation

The surge valve is a safety device which opens to prevent compressor surging. Compressor surge occurs when compressor outlet weight flow decreases below preset limits. Servo pressure from the surge control holds the surge valve closed for normal operation. A decrease in servo pressure allows the spring force to open the surge valve which vents a portion, or all of, the compressor discharge air to ambient.

The poppet valve actuates when the surge valve approaches the closed position. The poppet valve, when open, bleeds off servo pressure to maintain the minimum servo pressure required to hold the surge valve closed. Action of the poppet valve permits the surge valve to respond immediately to signals from the surge control.



Turbocompressor Surge Valve
Figure 1

TURBOCOMPRESSOR SURGE VALVE - MAINTENANCE PRACTICES

1. Removal/Installation Turbocompressor Surge Valve (see Figure 201)

   A. Remove Turbocompressor Surge Valve.

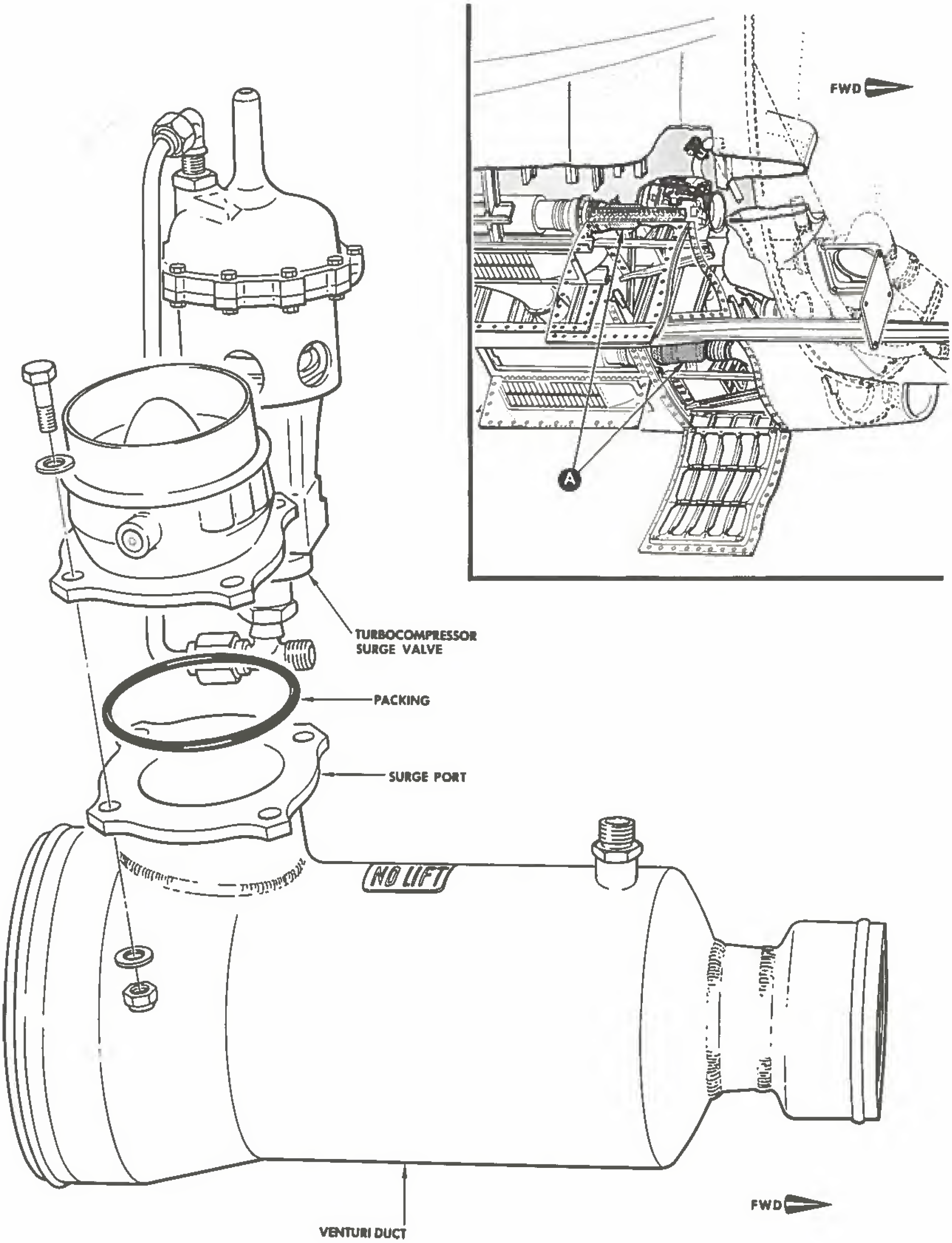
      (1) Remove venturi duct with surge valve attached (refer to 21-1-10, Maintenance Practices).

      (2) Remove flange nuts and bolts securing valve to venturi duct; remove valve and packing. (Bag and tag hardware for installation.)

   B. Install Turbocompressor Surge Valve.

      (1) Secure valve flange with packing to venturi duct surge port with retaining bolts and nuts.

      (2) Install venturi duct and surge valve on turbocompressor (refer to 21-1-10, Maintenance Practices).



Turbocompressor Surge Valve Installation
Figure 201

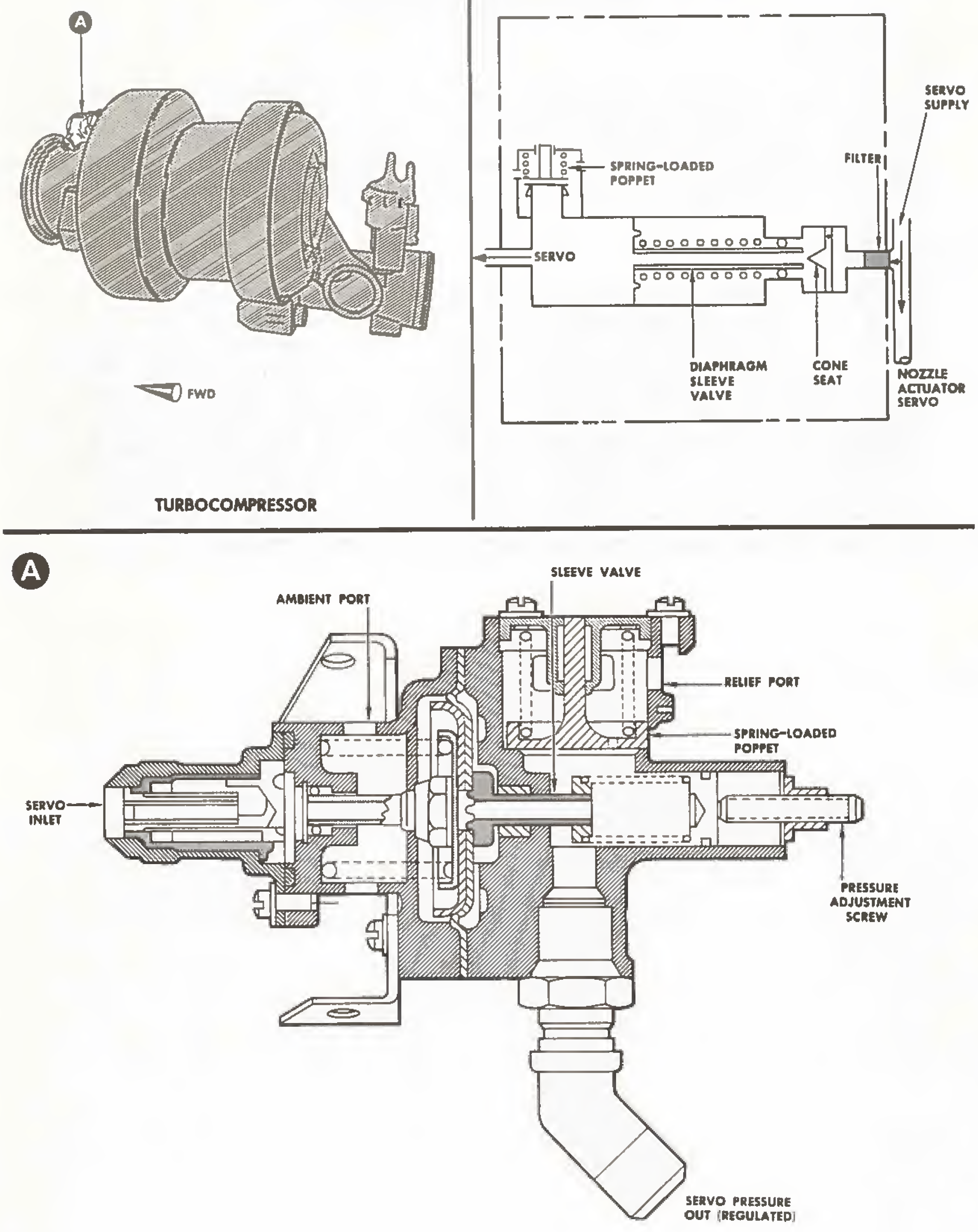
PRESSURE REGULATOR AND RELIEF VALVE - DESCRIPTION AND OPERATION

1. Description

The pressure regulator and relief valve, shown on Figure 1, consists of a filter, a diaphragm operated sleeve valve and a spring-loaded poppet. The pressure regulator and relief valve is mounted on the compressor inlet above the overspeed control box where it connects the servo pressure shut-off valve outlet to the flow, surge and recirculation servo tubes.

2. Operation

Cooled servo pressure from the servo pressure shutoff valve enters the regulator through a spring-loaded filter which insures the passage of clean servo air. If the filter screen becomes clogged the servo pressure will bypass the filter by forcing the screen to compress the spring. The filtered air passes through a cone shaped valve seat and through the metering sleeve to the diaphragm chamber. Increases in servo pressure cause the diaphragm to move the sleeve toward the cone seat thus regulating the servo supply pressure. The poppet will unseat at pressures slightly higher than regulated pressure thereby regulating servo supply at a higher level by bleeding excess pressure to ambient. The poppet valve relieves excess pressure thereby maintaining a maximum servo pressure limit.



Pressure Regulator and Relief Valve
Figure 1

PRESSURE REGULATOR AND RELIEF VALVE - MAINTENANCE PRACTICES

1. Removal/Installation Pressure Regulator and Relief Valve (see Figure 201)

   A. Remove Pressure Regulator and Relief Valve.

      (1) Remove turbocompressor package (refer to 21-1-0, Maintenance Practices).

      (2) Disconnect servo tube coupling nuts.

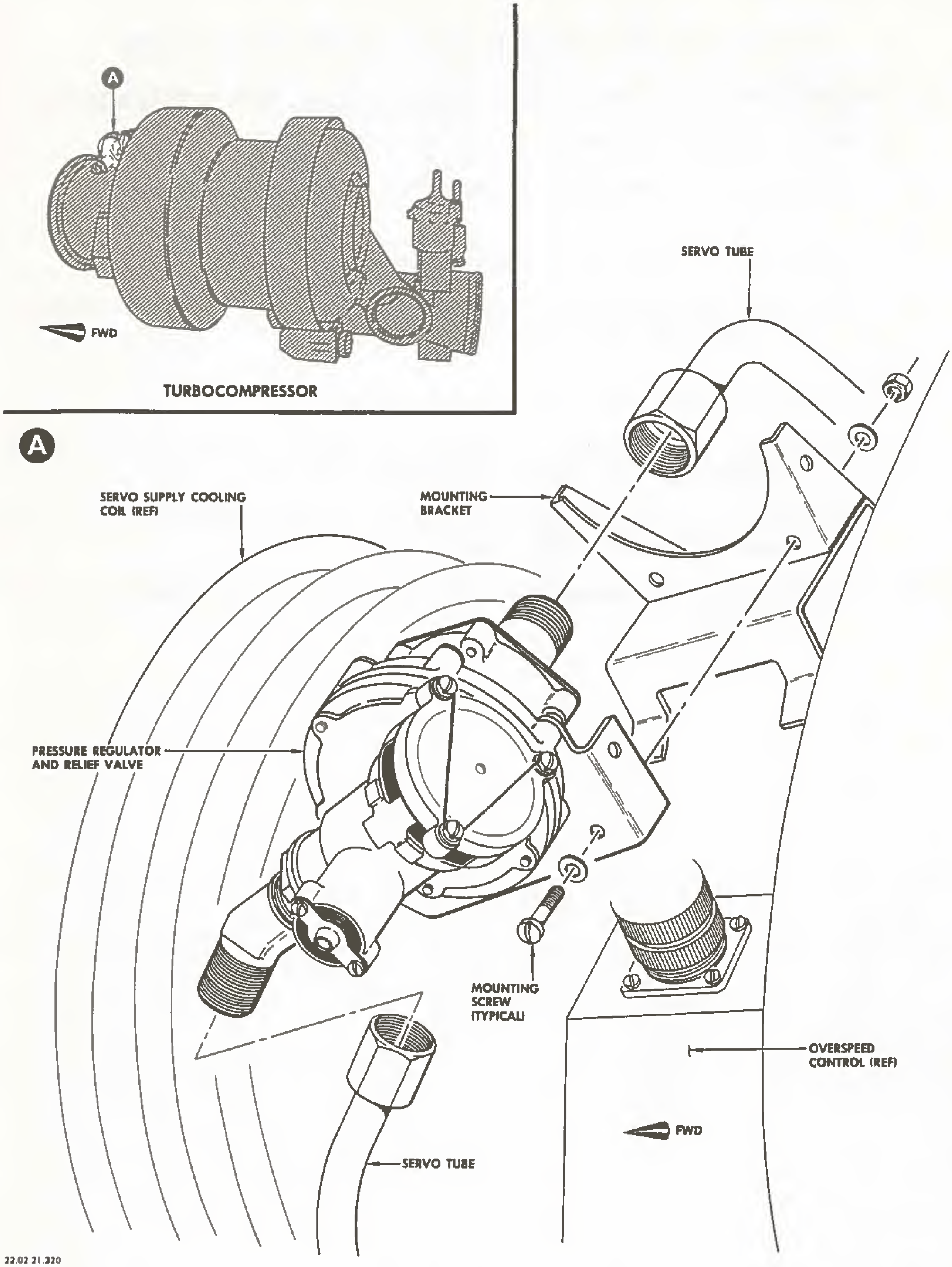
      (3) Remove retaining screws and nuts securing valve bracket to bracket on compressor inlet above overspeed control.

   B. Install Pressure Regulator and Relief Valve.

      (1) Install valve bracket to mounting bracket on compressor inlet above overspeed control; secure with screws and nuts.

      (2) Connect servo tubes to valve; tighten coupling nuts 1/6 to 1/3 turn beyond point of initial torque rise.

      (3) Install turbocompressor package (refer to 21-1-0, Maintenance Practices).



Pressure Regulator and Relief Valve Installation
Figure 201

RECIRCULATION ALTITUDE SHUTOFF CONTROL - DESCRIPTION AND OPERATION

1. Description

The recirculation altitude shutoff control consists essentially of a bellows operated poppet valve. A servo pressure line from the heat control valve is connected to the control on one side of the poppet valve; the opposite side of the control is vented to ambient.

2. Operation

When the airplane exceeds a predetermined altitude, the shutoff control bellows expands and actuates the poppet valve to the open position. Control servo pressure is vented to ambient through the open poppet valve to insure that the turbocompressor heat control modulating valve remains closed; additional heating (by recirculating air through the turbocompressor) is not required above the predetermined altitude.

RECIRCULATION ALTITUDE SHUTOFF CONTROL - MAINTENANCE PRACTICES

Removal/Installation Recirculation Altitude Shutoff Control (see Figure 201)

A. Remove Recirculation Altitude Shutoff Control.

(1) Remove turbocompressor package (refer to 21-1-0, Maintenance Practices).

(2) Loosen coupling nut and disconnect servo tube from shutoff control.

(3) Remove four retaining nuts securing shutoff control to mounting bracket attached to compressor shield; lower shutoff control from mounting bracket and remove washers, shockmounts, sleeves and packings from bracket.

(4) Loosen lock nut and remove elbow fitting from control; hold elbow for installation on replacement control.

B. Install Recirculation Altitude Shutoff Control.

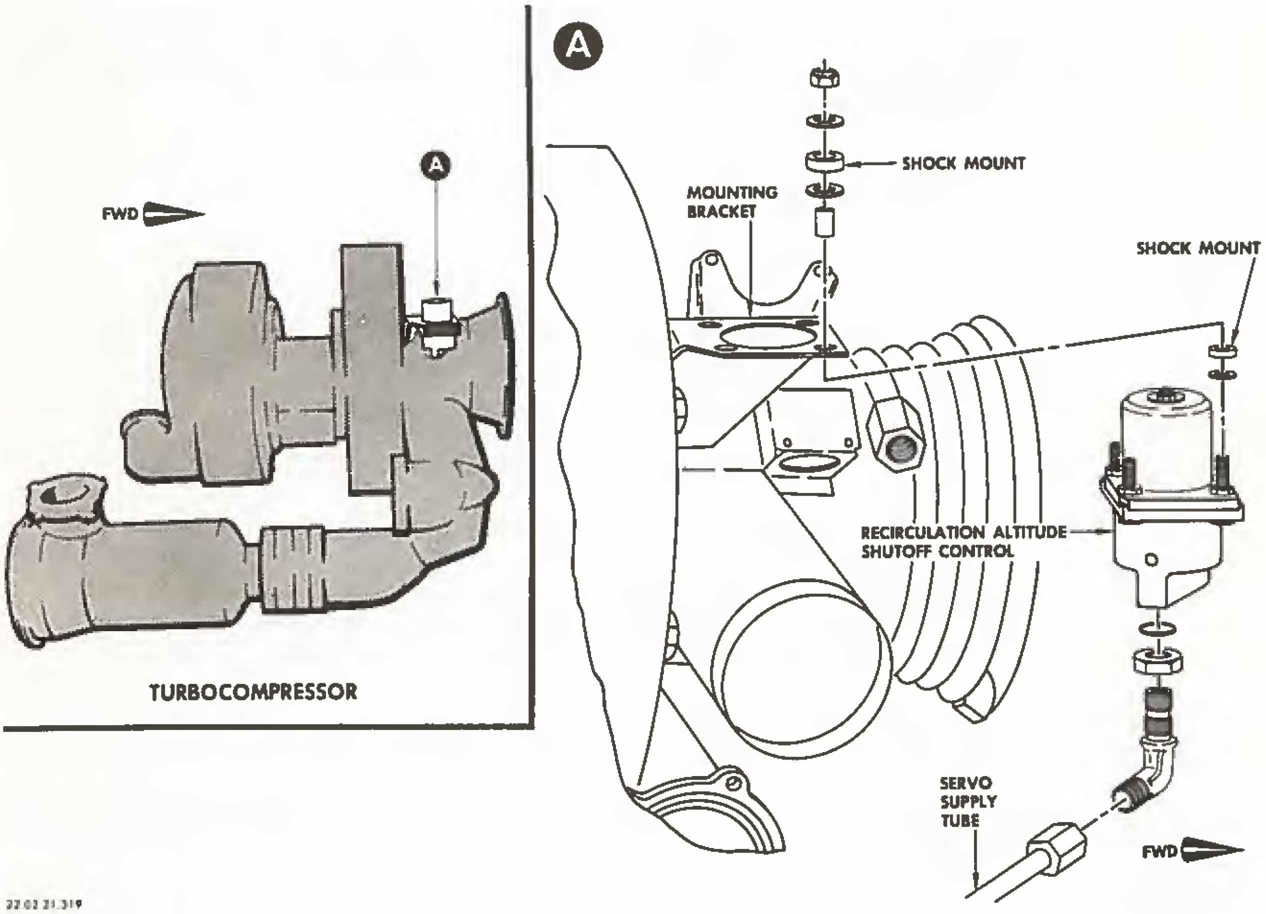
(1) Install elbow fitting in control port (port 88) pointing elbow toward the 11 o'clock position when viewing port 88 with port 87 at six o'clock position; secure elbow fitting lock nut.

NOTE: Use new packing when installing elbow fitting.

(2) Place washers, sleeves and shockmounts on control mounting studs and install shutoff control through bottom of mounting bracket (attached to compressor shield). Install control with elbow fitting pointing away from compressor inlet. Place packings over sleeves, add shockmounts and washers and secure with retaining nuts.

(3) Connect servo tube to shutoff control and tighten coupling nut 1/6 to 1/3 turn beyond point of initial torque rise.

(4) Install turbocompressor package (refer to 21-1-0, Maintenance Practices).



22 02 21.319

Recirculation Altitude Shutoff Control Installation
Figure 201

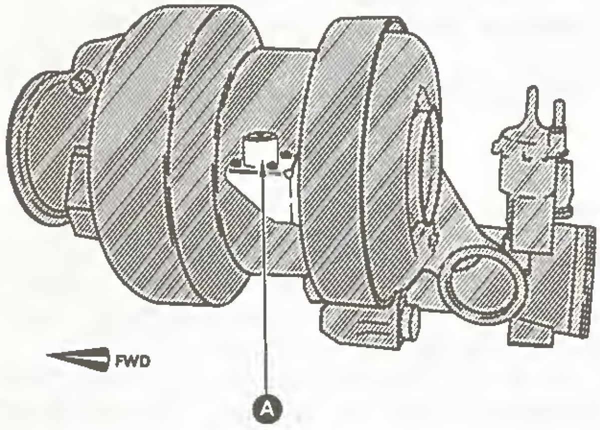
BIAS ALTITUDE CONTROL - DESCRIPTION AND OPERATION

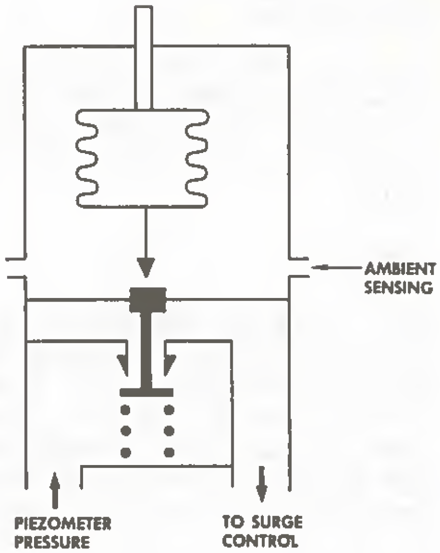
1. Description

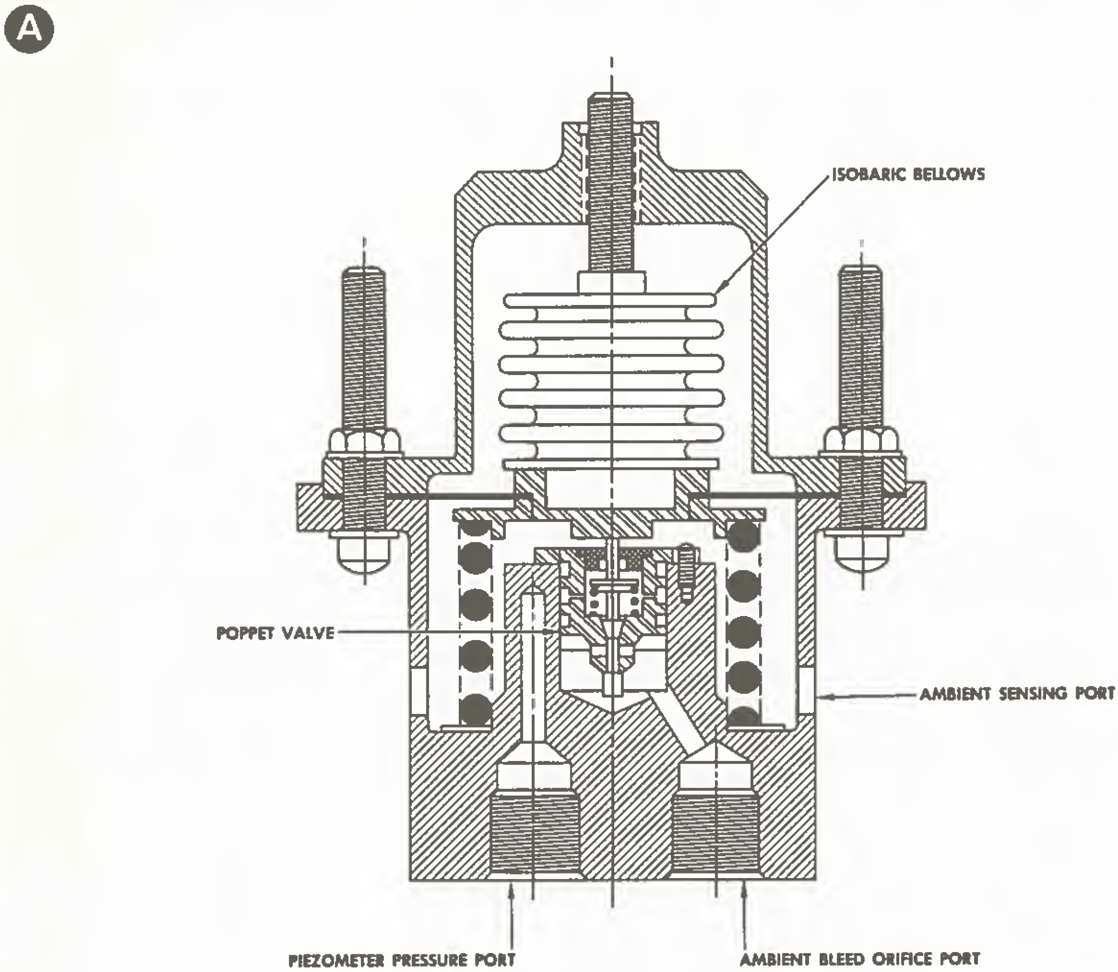
The bias altitude control, shown on Figure 1, consists essentially of a bellows-operated poppet valve. A pressure line from the piezometer is connected to the bias control on one side of the poppet valve and a surge control sensing line with fixed ambient bleed is connected to the opposite side.

2. Operation

The bias altitude control permits piezometer pressure to bypass an adjustable orifice of the surge control until the airplane exceeds the pressure altitude setting of the bias control. Below this altitude setting, maximum piezometer pressure is available to signal for a closed surge valve. When the airplane exceeds the pressure altitude setting of the bias control, the poppet valve closes forcing piezometer pressure through the adjusted orifice and into the surge control.







22.02.21.318

BIAS ALTITUDE CONTROL

Bias Altitude Control
Figure 1

BIAS ALTITUDE CONTROL - MAINTENANCE PRACTICES

1. Removal/Installation Bias Altitude Control (see Figure 201)

A. Remove Bias Altitude Control.

(1) Remove turbocompressor package (refer to 21-1-0, Maintenance Practices).

(2) Loosen coupling nuts and disconnect tubing connected to tee fitting on bottom of bias control and port 15 of surge control.

(3) Loosen coupling nuts and disconnect tubing connected to port 84 of bias control and tee fitting in port 20 of surge control; disconnect tubing from clamp attached to electrical harness.

(4) Remove four retaining nuts securing bias control to mounting bracket attached to compressor turbine shield; lower bias control from mounting bracket and remove washers, shockmounts, packings and sleeves from control and bracket.

(5) Loosen lock nut and remove tee fitting (with orifice plug) from control; hold tee for installation on replacement control.

(6) Remove union and O-ring from bottom of control; hold union for installation on replacement control.

B. Install Bias Altitude Control.

(1) Install tee fitting (with orifice plug) in port 85 and union in port 84 of bias control; use new O-rings when installing tee and union. Do not tighten tee or lock nut at this time.

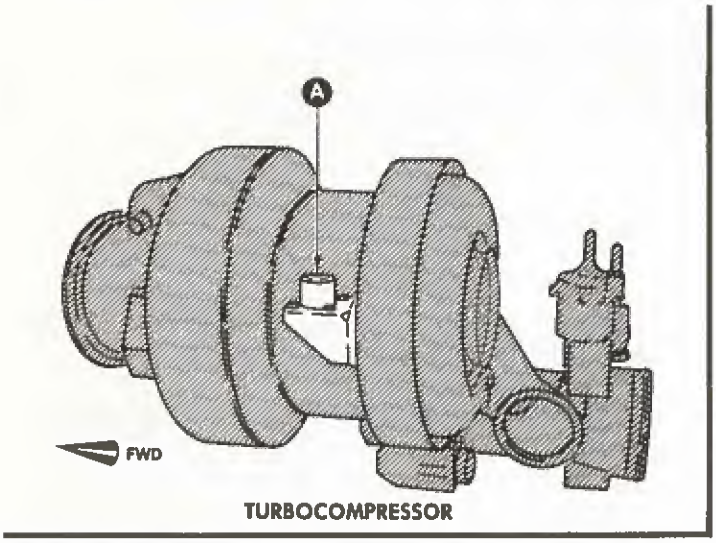
(2) Place washers, sleeves and shockmounts on control mounting studs and install control through bottom of mounting bracket (attached to compressor turbine shield). Place packings over sleeves, add shockmounts and washers and secure control with four retaining nuts.

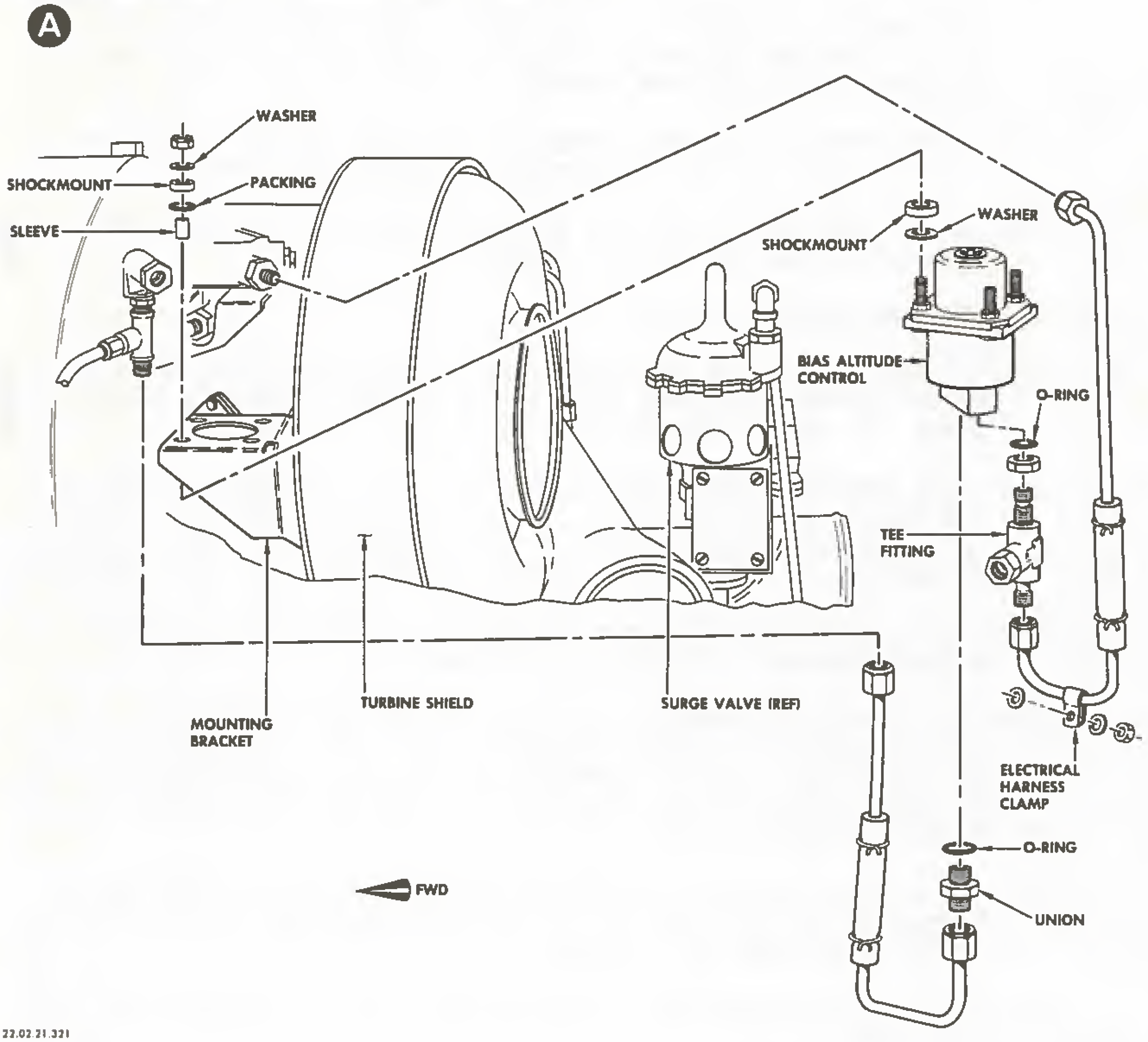
(3) Position tee fitting (installed in step (1)) pointing away from turbocompressor and secure with lock nut.

(4) Connect tubing between tee fitting on bias control and port 15 of surge control (above bias control); connect tubing between port 84 of bias control and tee fitting in port 20 of surge control. Tighten coupling nuts at ends of both tubes 1/6 to 1/3 turn beyond point of initial torque rise.

(5) Attach tube (connected to port 84 of bias control and tee fitting in port 20 of surge control) to electrical harness with clamp and secure with screw and lock nut.

(6) Install turbocompressor package (refer to 21-1-0, Maintenance Practices).





Bias Altitude Control Installation
Figure 201

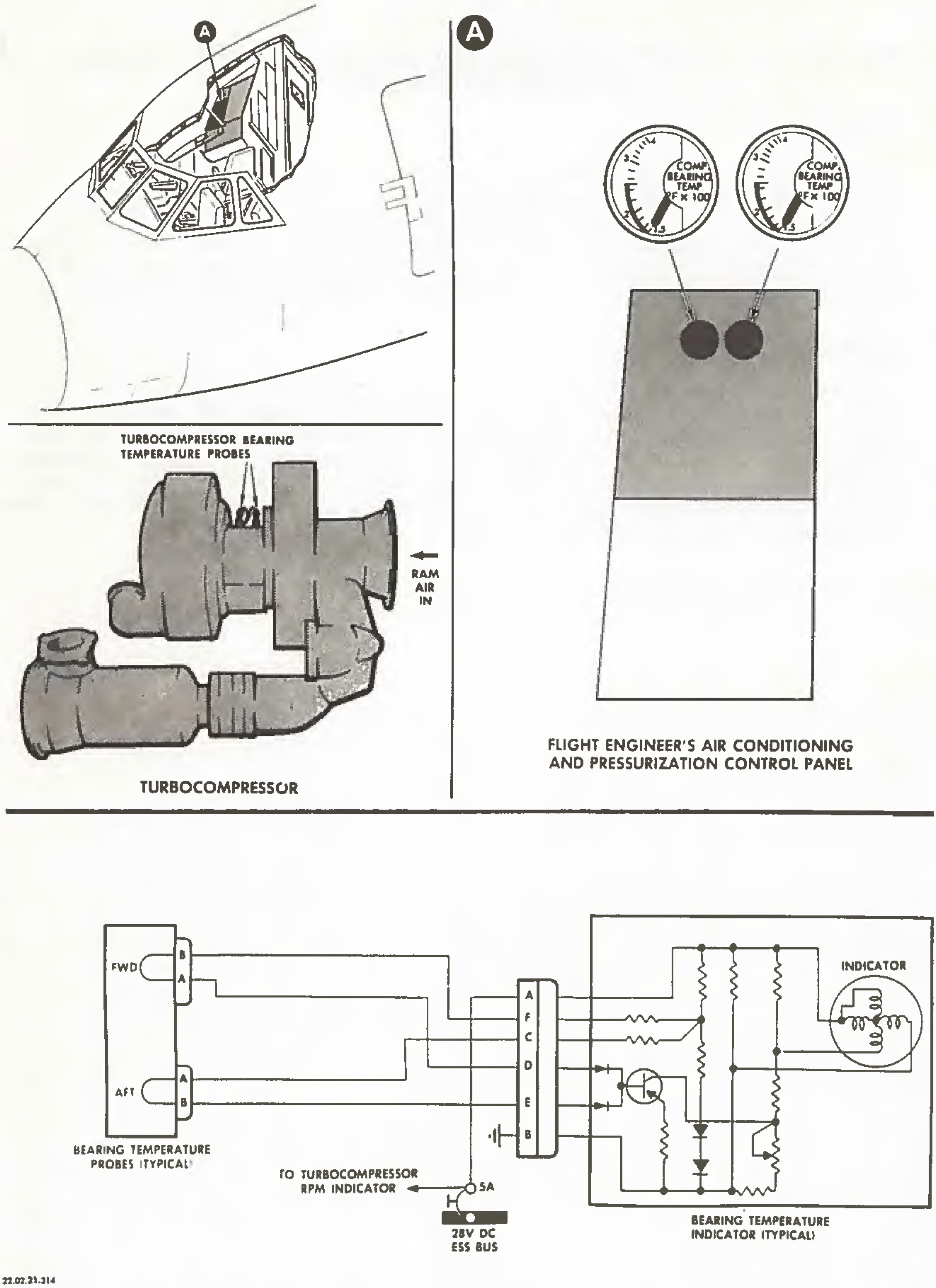
TURBOCOMPRESSOR BEARING TEMPERATURE INDICATOR AND TEMPERATURE PROBES - DESCRIPTION AND OPERATION

1. Description

Turbocompressor bearing temperature indicators for the cabin and flight compartment pressurization subsystems are located on the flight engineer's control panel. The indicators monitor the temperature of the two bearings on each turbocompressor and indicate the temperature of the hottest bearing. See Figure 1 for a schematic of the turbocompressor bearing temperature indicator system. The cabin and flight compartment systems are identical.

2. Operation

A temperature probe is mounted next to the forward and aft bearing of the rotor. They contain thermistors that decrease in electrical resistance as temperature increases. The two probes are connected to the transistorized control circuit housed in the back of the indicator on the flight engineer's control panel. The position of the temperature indicating needle is determined by the probe with the least resistance -- or highest temperature. The temperature indicator dial has a range of 150 to 400 degrees F.



Turbocompressor Bearing Temperature Indicator
Figure 1

TURBOCOMPRESSOR BEARING TEMPERATURE INDICATOR AND TEMPERATURE PROBES - MAINTENANCE PRACTICES

1. Removal/Installation Turbocompressor Bearing Temperature Indicator

NOTE: For Removal/Installation of turbocompressor bearing temperature indicator, refer to Chapter 31, INSTRUMENTS.

2. Removal/Installation Turbocompressor Bearing Temperature Probe (See Figure 201)

A. Remove Turbocompressor Bearing Temperature Probe.

(1) Remove turbocompressor package (cabin or flight compartment) from airplane (refer to 21-1-0, Maintenance Practices).

(2) Disconnect electrical connector from temperature probe. Forward and aft temperature probes are located along the top centerline of bearing housing between the turbine and impeller.

(3) Remove safety wire from probe.

(4) Remove probe by turning counterclockwise.

(5) Cover opening to prevent entry of dust and dirt into compressor housing.

B. Install Turbocompressor Bearing Temperature Probe.

(1) Install and tighten temperature probe in opening provided on top of bearing housing.

(2) Install safety wire on temperature probe.

(3) Connect electrical connector to probe.

(4) Install turbocompressor package in airplane (refer to 21-1-0, Maintenance Practices).

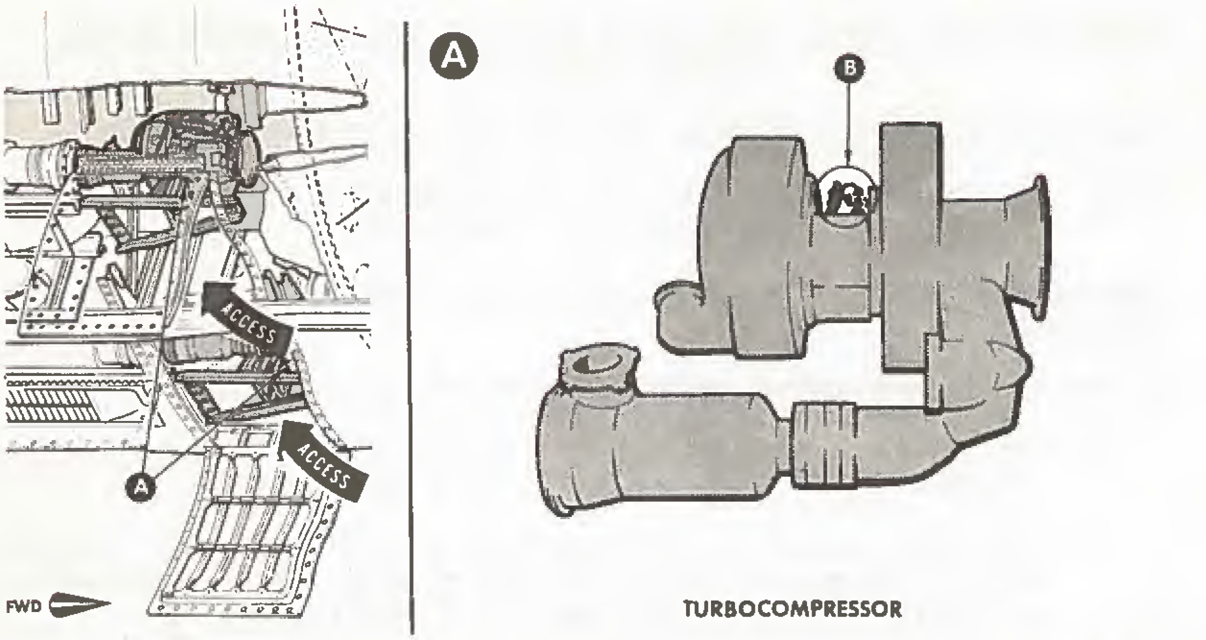
(5) Perform operational test of indicator (refer to Adjustment/Test Bearing Temperature Indicator).

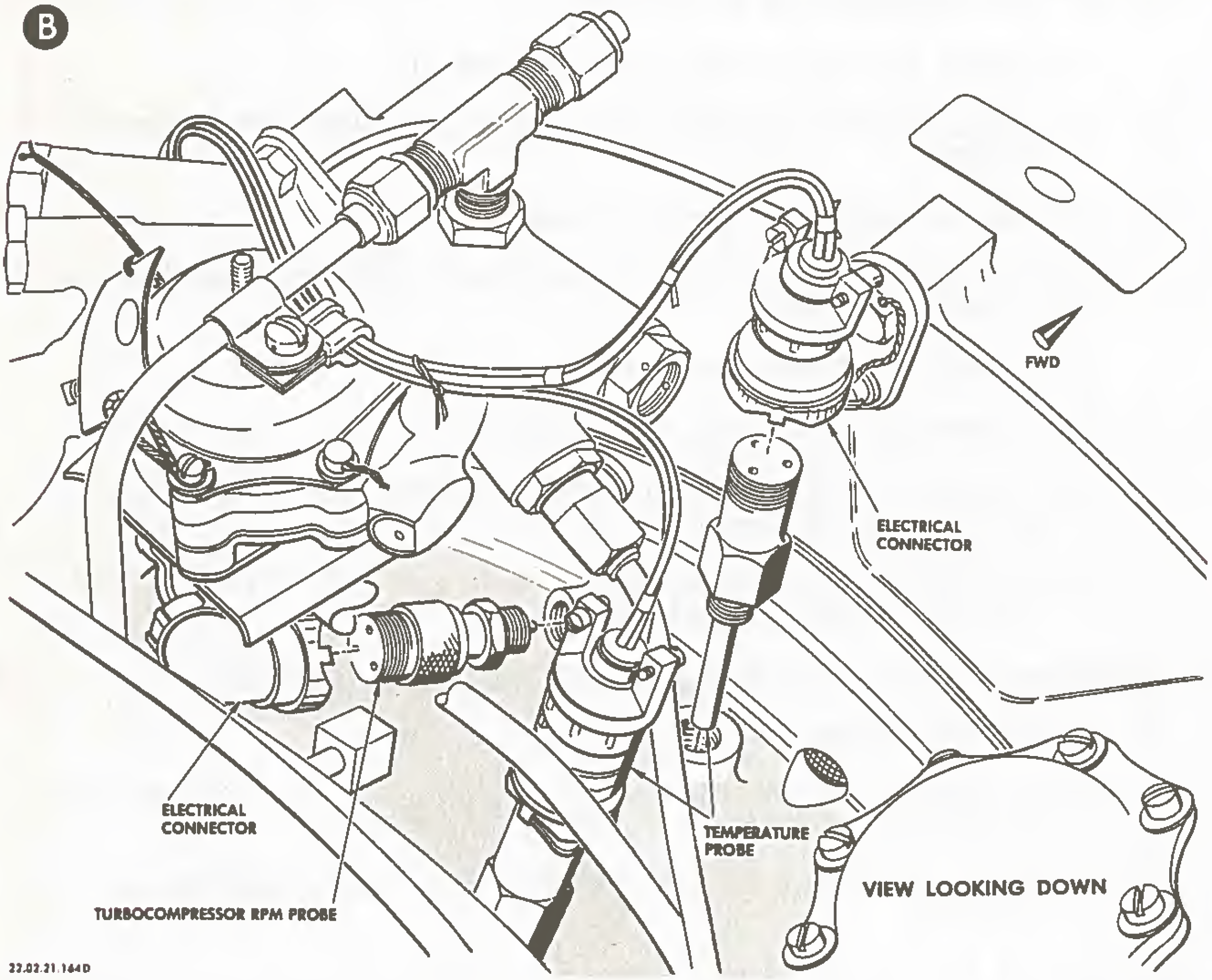
3. Adjustment/Test Turbocompressor Bearing Temperature Indicator

A. Equipment Required.

(1) External source of 115/200-volt, 3-phase, 400 cycle ac electrical power (refer to Chapter 24, ELECTRICAL POWER).

(2) Decade resistance box calibrated to test points specified in Table I.





Turbocompressor Temperature
and RPM Probe Installation
Figure 201

(3) Fixed resistor at 1000 Ohms (±3%) and harness leads.

Table I

INDICATOR READING °F	RESISTANCE OHMS	RESISTANCE TOLERANCE (OHMS)
200°	435	105
250°	215	60
300°	113	16
350°	65	16

B. Preparation.

(1) Open turbocompressor access door (cabin or flight deck).

(2) Disconnect electrical control harness from turbocompressor receptacle. (Receptacle is located under turbine exhaust.)

(3) Connect variable resistor to pins E and F on cabin turbocompressor electrical plug. Set resistance at 100 Ohms.

(4) Connect 1000 Ohm resistor between pins C and D of cabin turbocompressor electrical plug.

(5) Connect and apply external electrical power to airplane (refer to Chapter 24, ELECTRICAL POWER).

(6) Close TURBC COMPR IND circuit breaker (cabin or flight deck).

C. Test Turbocompressor Bearing Temperature Indicator.

(1) Vary resistance to test points (pins E and F) per Table I and check cabin COMPR BEARING TEMP indicator on flight engineer's control panel; indicator reading shall be within tolerances specified in Table I.

(2) Reverse leads so that variable resistor is between pins C and D and fixed resistor is between pins E and F; repeat step (1), substituting pins C and D for E and F.

(3) Repeat steps (1) and (2) substituting flight deck for cabin.

(4) Open TURBO COMPR IND circuit breaker (cabin or flight deck).

(5) Remove variable and fixed resistors from turbocompressor electrical plug.

(6) Connect turbocompressor electrical harness plug to electrical receptacle.

(7) Close turbocompressor access doors.

(8) Remove external source of electrical power from airplane.

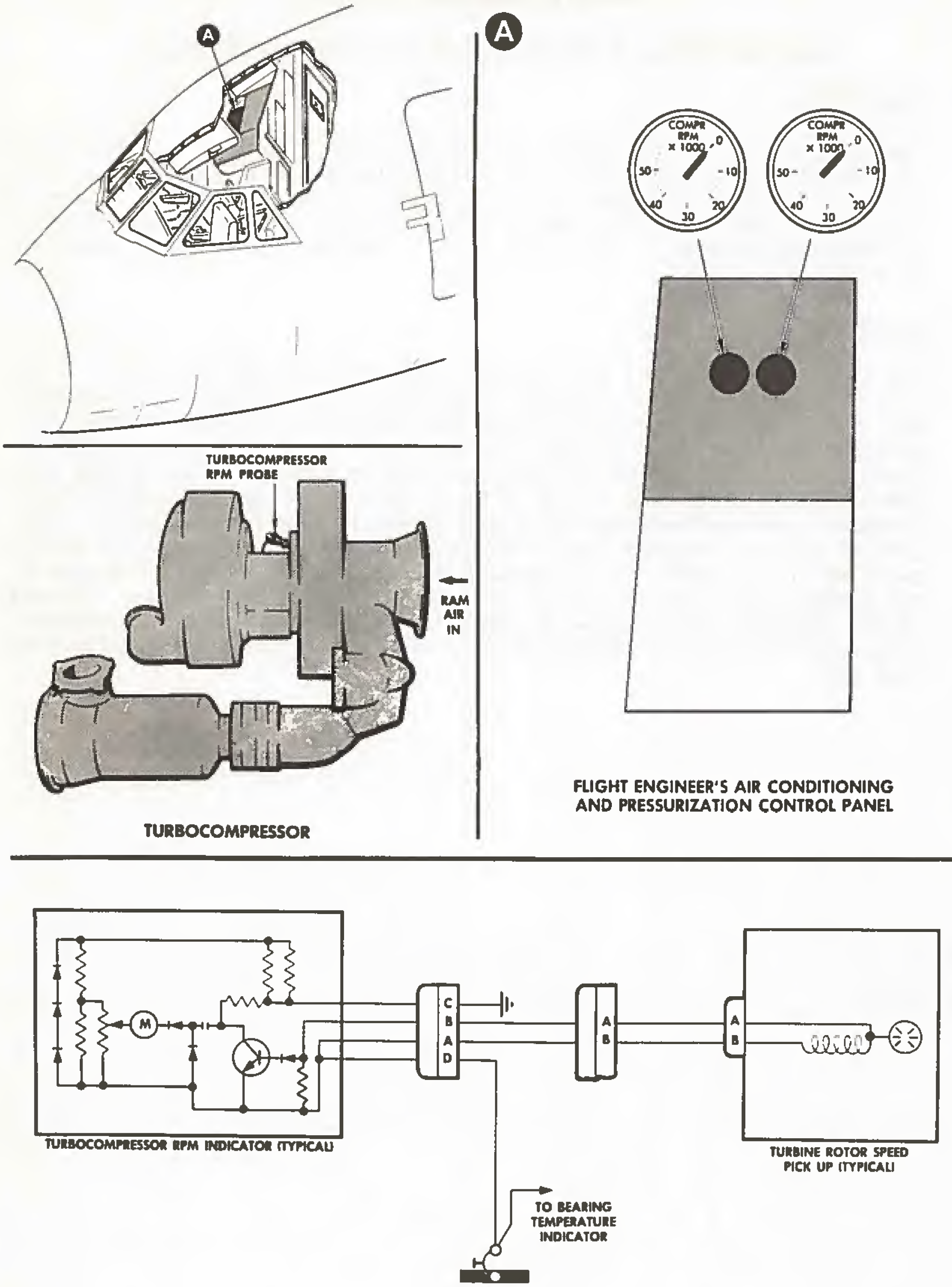
TURBOCOMPRESSOR RPM INDICATOR - DESCRIPTION AND OPERATION

1. Description

Turbocompressor rpm indicators for the cabin and flight compartment pressurization systems are located on the flight engineer's control panel. They are used to detect improper operation of the turbocompressors, and are useful in troubleshooting the pressurization systems. The two rpm indicator systems are identical. See Figure 1 for a schematic of the rpm indicator circuit.

2. Operation

The system consists of a rotor speed pickup coil and the indicator. The rotor speed pickup coil is mounted near the rotating seal on the impeller end of the rotor. Electrical pulses are induced in the electro-magnetic pickup coil by six lugs on the rotating seal. The lugs cut the magnetic field of the electro-magnetic pickup to induce a pulse in the pickup coil. These pulses, whose rate varies directly with rotor rpm are coupled to a transistorized control circuit housed in the back of the indicator. The control circuit converts the pulses into a steady dc current which is proportional to the rate of the incoming pulses. The dc current operates a milliammeter which is calibrated to read revolutions per minute. The dial of the indicator has a range of zero to sixty thousand rpm. The maximum safe operating speed is indicated by a red mark on the dial at fifty thousand rpm.



22.30.21.045B

Turbocompressor RPM Indicator
Figure 1

TURBOCOMPRESSOR RPM INDICATOR - MAINTENANCE PRACTICES

1. Removal/Installation Turbocompressor RPM Indicator

NOTE: For Removal/Installation of the turbocompressor RPM indicator, refer to Chapter 31, INSTRUMENTS.

2. Removal/Installation Turbocompressor RPM Pickup Probe (refer to 21-1-8, Figure 201).

A. Remove RPM Pickup Probe.

(1) Remove turbocompressor package (cabin or flight compartment, as required) from airplane (refer to 21-1-0, Maintenance Practices).

(2) Remove bias altitude control (refer to 21-1-7, Maintenance Practices).

(3) Remove safety wire from lock nut on RPM probe. Probe is located on the left side of turbocompressor between the turbine and compressor. The probe is installed pointing down and forward.

(4) Disconnect electrical connector from RPM probe. (Tag for installation.)

(5) Loosen lock nut at base of RPM probe.

(6) Using fingers, twist knurled portion of probe to back it out of housing.

(7) Cover opening to prevent entry of dust and dirt into compressor housing.

B. Install RPM Pickup Probe.

(1) Screw lock nut up to the knurled portion of the probe.

(2) Using fingers only, position probe in opening and screw in until probe touches lugs on rotating seal.

CAUTION: MAKE SURE THAT PROBE CONTACTS LUG BY SLOWLY TURNING IMPELLER. BACK OUT ON PROBE FOR ONE-HALF A TURN, HOLD IN POSITION, AND TIGHTEN LOCK NUT. ROTATE IMPELLER BY HAND TO DETERMINE THAT PROBE CLEARS THE ROTATING SEAL AT ALL POINTS.

(3) Install safety wire on RPM probe lock nut.

(4) Connect electrical connector to probe.

(5) Install bias altitude control (refer to 21-1-7, Maintenance Practices).

(6) Install turbocompressor package in airplane (refer to 21-1-0, Maintenance Practices).

(7) Operate turbocompressor to check indicator operation (refer to 21-0, Maintenance Practices).

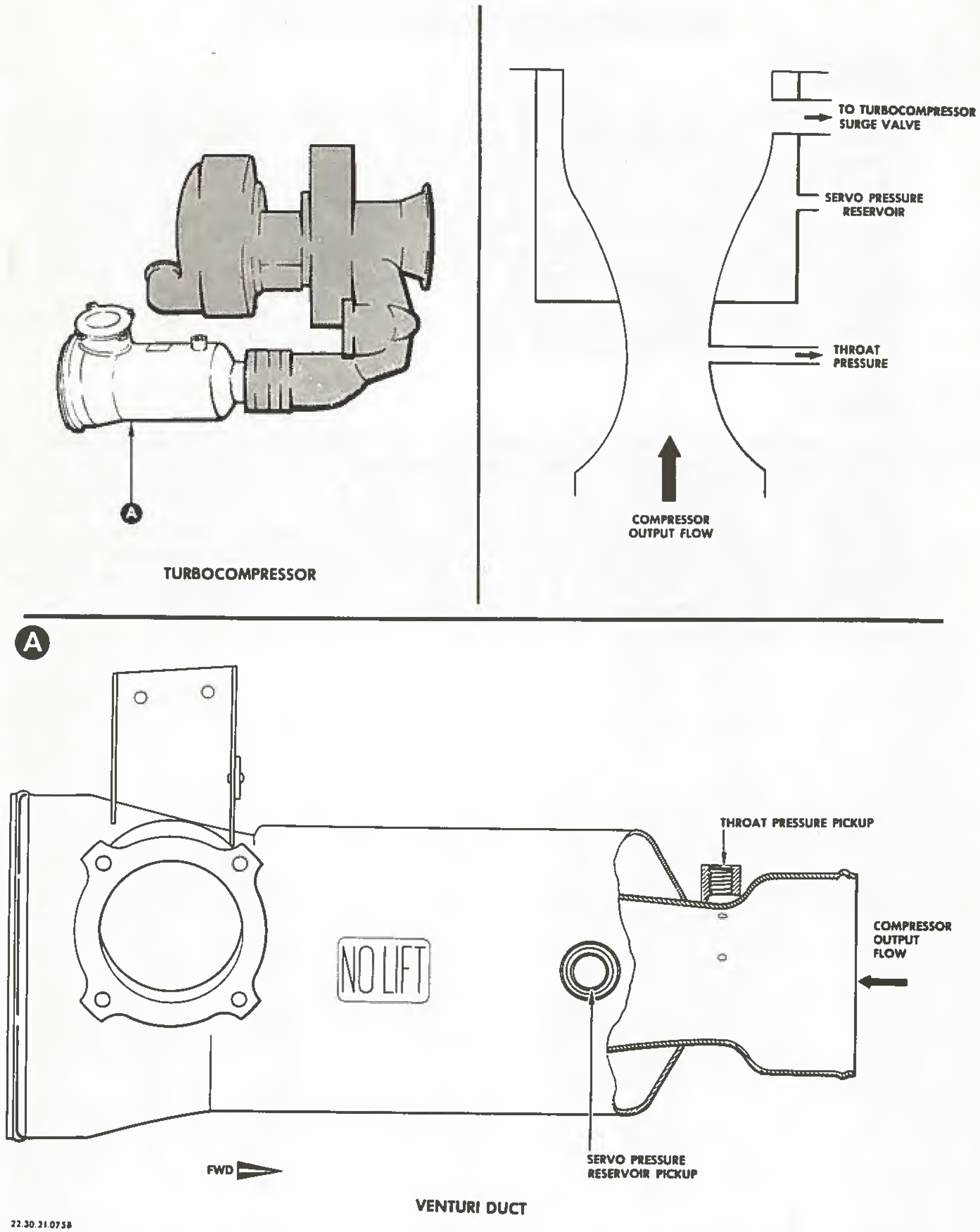
VENTURI DUCT - DESCRIPTION AND OPERATION

1. Description

The venturi duct is the turbocompressor outlet. The duct, illustrated on Figure 1, is constricted near the attachment to the piezometer ring on the transition outlet duct of the compressor. The outlet end of the duct is flared and contains a flanged mounting surface for attachment of a surge valve. A sensing line to the flow control connects into the constriction. The piezometer ring is not physically a part of the venturi duct but functions with the venturi. The piezometer ring encircles the transition outlet duct over eight equally spaced holes drilled into the bore. A sensing line connects the piezometer to the flow control and a side port, tapped straight into the bore, is connected to the pressure limiter control. The venturi duct is encompassed by a servo pressure reservoir.

2. Operation

Turbocompressor outlet flow is sensed by the flow control through pickups on the venturi duct. As outlet flow increases, throat pressure at the constriction decreases in relation to duct pressure sensed through the piezometer. The reduction in pressure is sensed by the flow control which, in turn, regulates servo pressure to the nozzle actuator. The nozzle actuator controls RPM to maintain the desired rate of flow. The servo pressure reservoir maintains a steady servo pressure source which stabilizes turbocompressor operation when the normal servo supply is subject to rapid pressure transients.



Venturi Duct
Figure 1

VENTURI DUCT - MAINTENANCE PRACTICES

1. Removal/Installation Venturi Duct (see Figure 201)

   A. Remove Venturi Duct.

      CAUTION: REMOVAL OF THE VENTURI DUCT FROM THE TURBOCOMPRESSOR IS PROHIBITED DURING LINE MAINTENANCE UNLESS THE SAME VENTURI DUCT IS INSTALLED ON THE TURBOCOMPRESSOR FROM WHICH IT WAS REMOVED. THE VENTURI DUCT AND TURBOCOMPRESSOR ARE MATED PARTS AND ARE NOT INTERCHANGEABLE WITH OTHER UNITS. IN CASE OF A DAMAGED VENTURI DUCT, THE ENTIRE TURBOCOMPRESSOR PACKAGE MUST BE REPLACED.

      (1) Disconnect and remove duct clamps from each end of venturi duct.

      (2) Disconnect three flexible servo lines from venturi duct; tag lines for installation. (Cap open lines and fittings.)

      (3) Remove bolts securing venturi duct to turbocompressor "A" Frame; remove venturi duct with surge valve attached.

   B. Install Venturi Duct.

      CAUTION: IN STEPS (1) AND (2) TIGHTEN DUCT CLAMP SCREWS FINGER TIGHT ONLY.

      (1) Install venturi duct (surge valve attached) by placing small diameter end into turbocompressor outlet duct; install and secure duct clamp.

      (2) Connect outlet end of venturi to turbocompressor check valve duct and install and secure duct clamp.

      (3) Install bolts through venturi duct mounting bracket and turbocompressor "A" Frame; tighten bolts.

      (4) Connect three flexible servo lines to venturi duct; tighten coupling nuts.

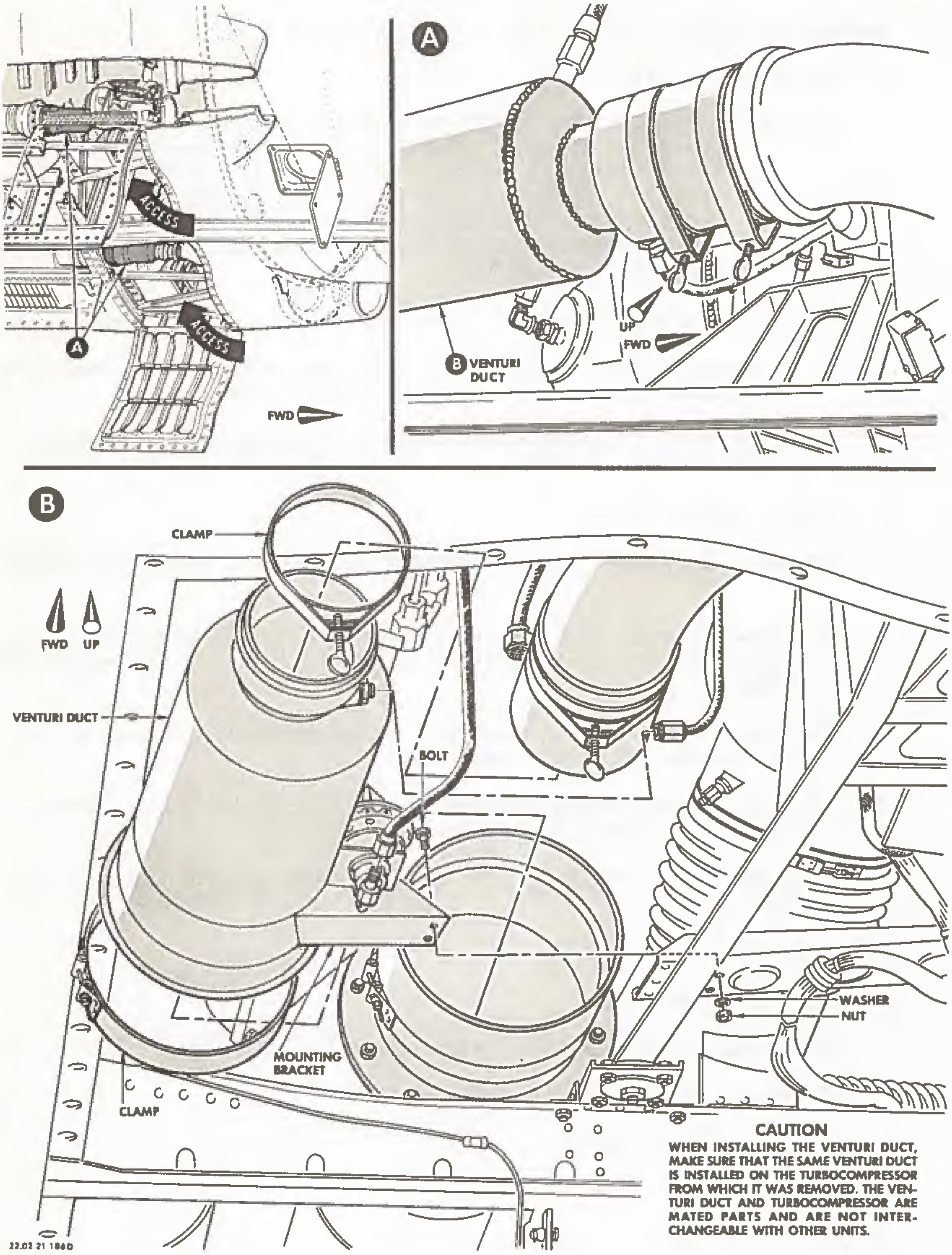
2. Adjustment/Test

   A. Equipment Required.

      (1) Pressure caps capable of withstanding 40 psi.

      (2) Reducer fitting (AN 919-3D).

      (3) Air pressure source.



CAUTION
WHEN INSTALLING THE VENTURI DUCT, MAKE SURE THAT THE SAME VENTURI DUCT IS INSTALLED ON THE TURBOCOMPRESSOR FROM WHICH IT WAS REMOVED. THE VENTURI DUCT AND TURBOCOMPRESSOR ARE MATED PARTS AND ARE NOT INTERCHANGEABLE WITH OTHER UNITS.

Venturi Duct Installation
Figure 201

B. Venturi Leak Test.

(1) Plug tapped venturi boss and cap venturi inlet and surge valve port (surge valve removed).

(2) Cap venturi outlet with cap containing air pressure fitting.

(3) Pressurize venturi to 18 psig maximum through air fitting on outlet cap, then shut off air pressure. Venturi shall maintain pressure with no detectable pressure loss during five minute test period.

C. Venturi Air Chamber Leak Test.

(1) Cap air chamber port on top of venturi with reducer fitting (AN 919-3D).

(2) Pressurize air chamber to 30 psig maximum through reducer fitting, then shut off air pressure. Air chamber shall maintain pressure with no detectable pressure loss during five minute test period.

3. Inspection/Check

A. Examine external condition of venturi tube.

(1) Check tapped boss for work or damaged threads.

(2) Examine painted surfaces for wear or damage.

(3) Check all exposed metal for corrosion.

(4) Note any dents in the duct that may effect air flow or flow sensing.

(5) Examine ribbed connecting ends for damage that might cause leakage.

(6) Check turbocompressor package mounting bracket for bending or other damage.

(7) Check duct bore for burrs, cracks, or dents that might affect air flow.

(8) Examine four 0.055 inch holes in venturi pickup for dirt.

4. Cleaning/Painting

A. Clean Venturi Duct.

(1) Clean venturi duct by immersion, swabbing, or brushing with AMS 3160A solvent to remove oil and grease deposits.

WARNING: DO NOT ALLOW SOLVENT TO ENTER AIR CHAMBER; DRY BORE THOROUGHLY WITH A DRY LINTLESS CLOTH.

(2) When damage does not exceed one square inch or five percent of total painted area, touch up surface using one coat of AMS 3120B and allow to dry for at least four hours.

SERVO PRESSURE SHUTOFF VALVE - DESCRIPTION AND OPERATION

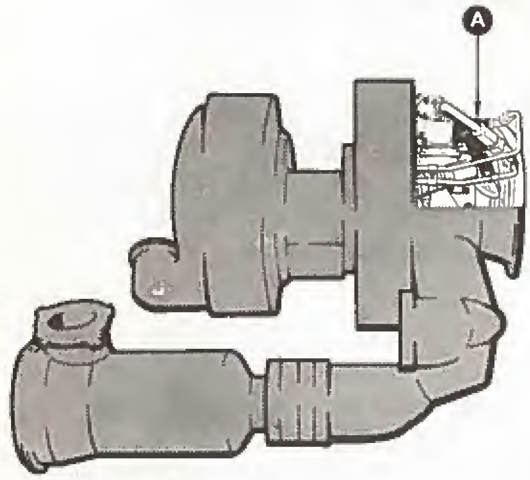
1. Description

The servo pressure shutoff valve, shown on Figure 1, consists of a turbine-pressure sensing chamber and a piston-operated ball valve. The shutoff valve is mounted on top of the compressor ram air inlet and is connected to the bleed air servo supply, pressure regulator and nozzle actuator servo pressure lines, and the compressor turbine exhaust scroll.

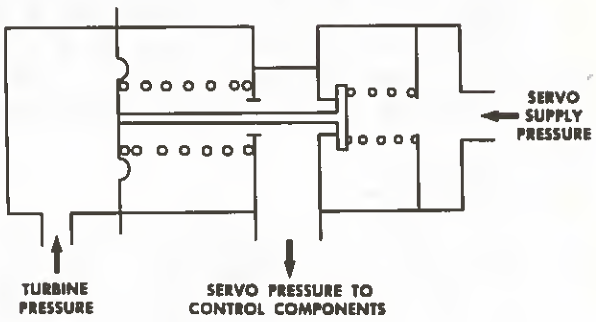
2. Operation

The servo pressure shutoff valve prevents high pressure bleed air from striking the compressor turbine impeller vanes when the variable area nozzle vanes are in the full open position. When the turbocompressor bleed air shutoff valve closes, turbine pressure in the servo pressure shutoff valve sensing chamber decreases and allows the piston-operated ball valve to seat. When the ball valve seats, servo supply pressure to the nozzle actuator is shutoff thereby closing the nozzle vanes in the turbine.

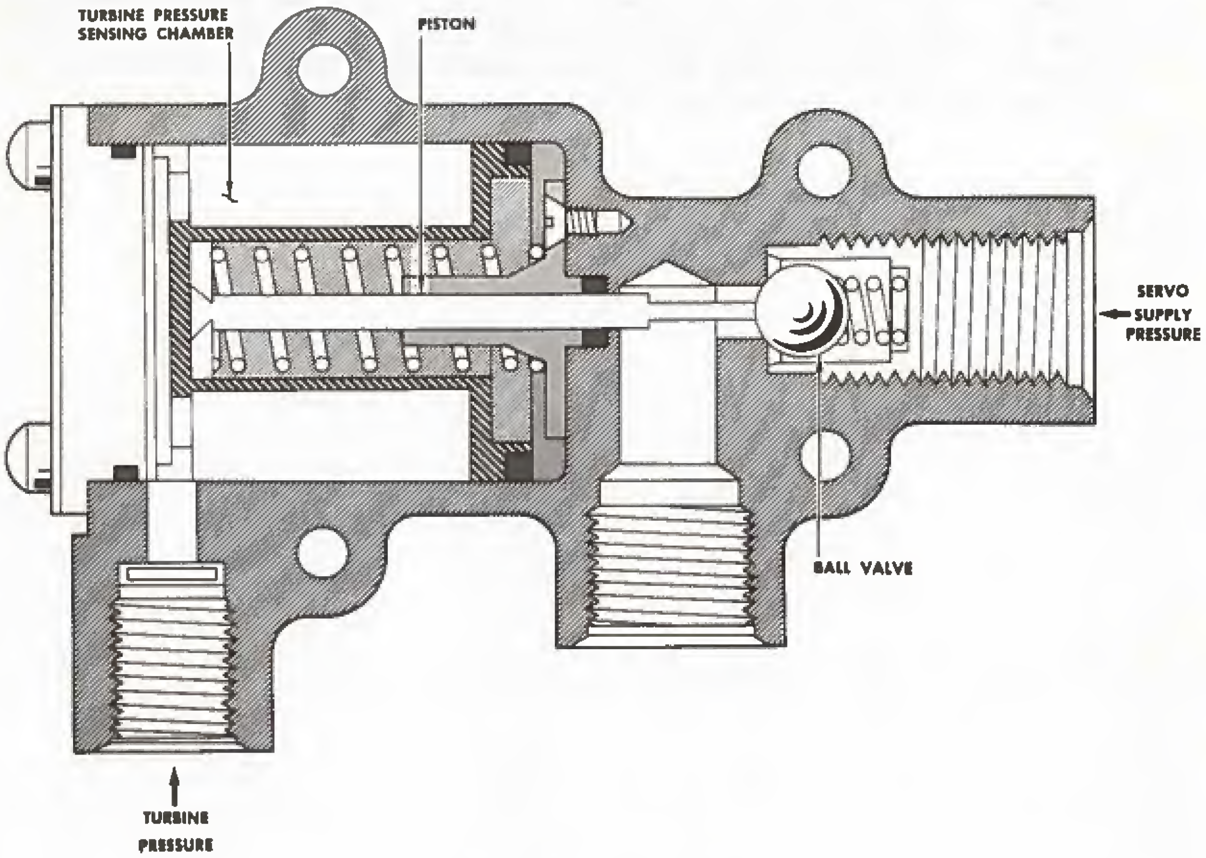
When the bleed air shutoff valve opens, turbine pressure increases in the servo pressure shutoff valve sensing chamber. When this pressure reaches a preset limit, the piston unseats the ball valve and allows servo pressure to enter the nozzle actuator which opens the nozzle vanes. This sequence of operation opens the nozzle vanes gradually to permit only a gradual acceleration of the turbine.



TURBOCOMPRESSOR



A



SERVO PRESSURE SHUTOFF VALVE

22.02.21.301

Turbocompressor Servo Pressure Shutoff Valve
Figure 1

PRESSURIZATION CONTROLS AND INDICATION - DESCRIPTION AND OPERATION

1. General

Cabin pressurization, shown schematically on Figure 1, is controlled automatically by a cabin pressure controller which regulates the amount of air exhausted through two pressure regulating outflow valves. The cabin pressure controller is located on the flight engineer's control panel, shown on Figure 2, and is completely pneumatic in operation. An electrically driven override is provided on the outflow valves to permit manual operation.

Pressurization air is normally delivered to the cabin from two turbocompressors, but in an emergency, it can be obtained directly from the engine bleed air system. In either case, a steady input to pressurize the compartments is available. The pressure level, or cabin altitude, is then controlled by regulating the amount of air dumped overboard through the outflow valves.

The pressure control system automatically maintains the selected cabin altitude as long as the design limits are not exceeded. It will limit the cabin-to-atmosphere pressure differential to 8.30 (±0.1) psi. If there is a malfunction in the automatic regulation of cabin pressure, each outflow valve has a pneumatic and an electrical pressure relief calibrated at 8.50 (±0.1) psig. There are similar pneumatic and electric features to limit cabin vacuum differential to approximately 0.36 psi. There are also cabin altitude limiting controls which will automatically close the outflow valves enough to maintain a cabin altitude of approximately 13,000 feet. If all of these safety devices fail to perform in both outflow valves, the flight engineer can manually control cabin pressure with the electrically driven override.

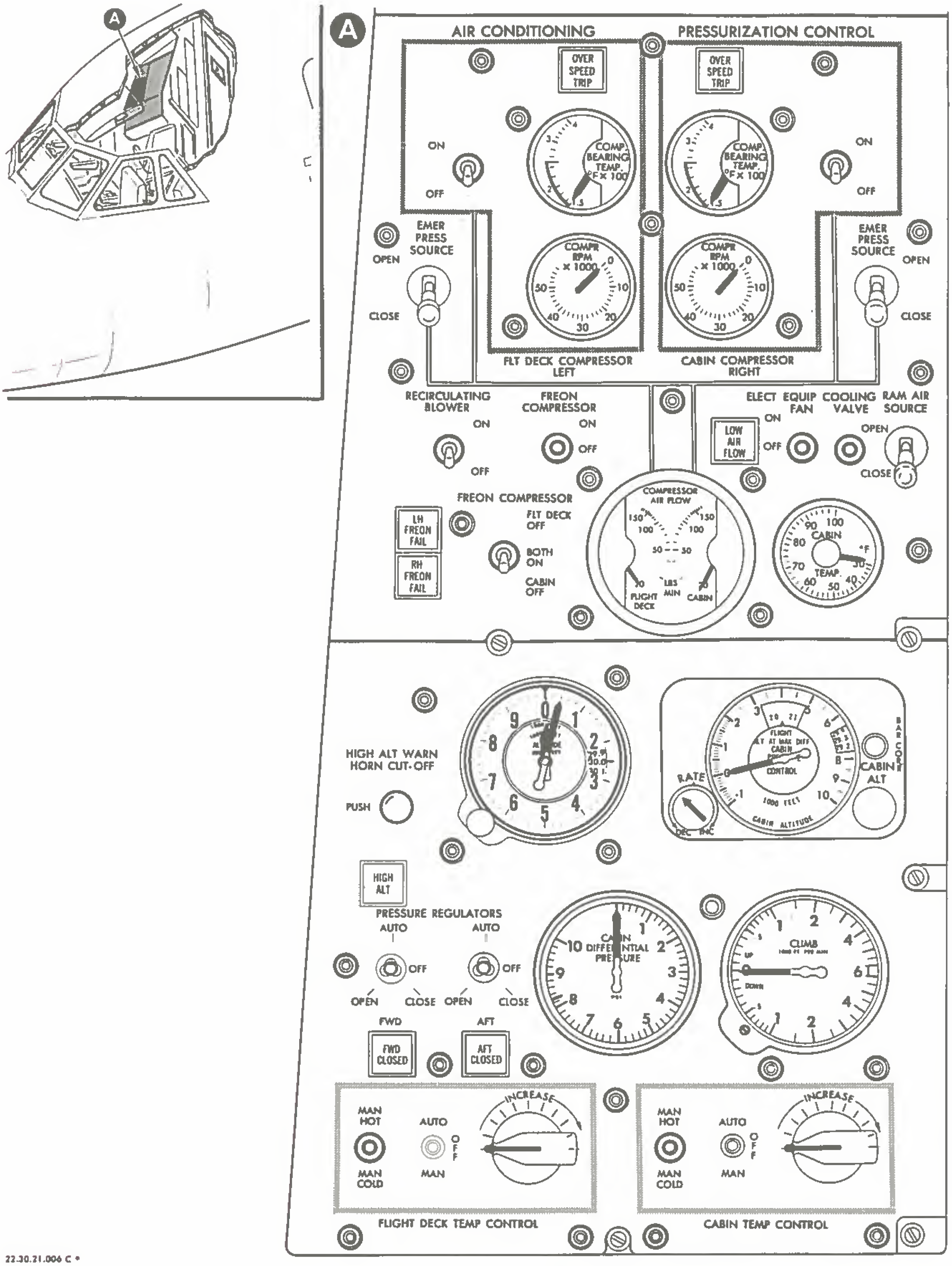
The normal allowable cabin pressure differential of 8.30 psi will provide a sea-level cabin altitude up to a flight altitude of approximately 20,500 feet. An 8,000 foot cabin altitude can be maintained at 41,000 feet. In addition to the cabin pressure controller, there are control switches for manual operation of the outflow valves, a cabin altimeter, a cabin rate of climb indicator, and a differential pressure gauge. Warning lights are provided to indicate closed outflow valves, and to indicate excessively high cabin altitudes. A warning horn also provides an audio alarm for excessive cabin altitude. The control panel for cabin pressurization is illustrated in Figure 2.

The cabin pressure controller has three control knobs and three indicators on its face. The CABIN ALTITUDE knob sets the desired cabin altitude on the main dial of the pressure controller, and the RATE knob sets the rate of change in cabin altitude. The BAR CORR knob is used to correct for variations in pressure altitude. It is set to the local altimeter setting. A small window at the top of the main dial indicates the maximum flight

altitude at which the selected cabin altitude can be maintained. If the airplane climbs higher than the altitude indicated, the pressure controller will automatically limit the cabin pressure differential to 8.30 psi.

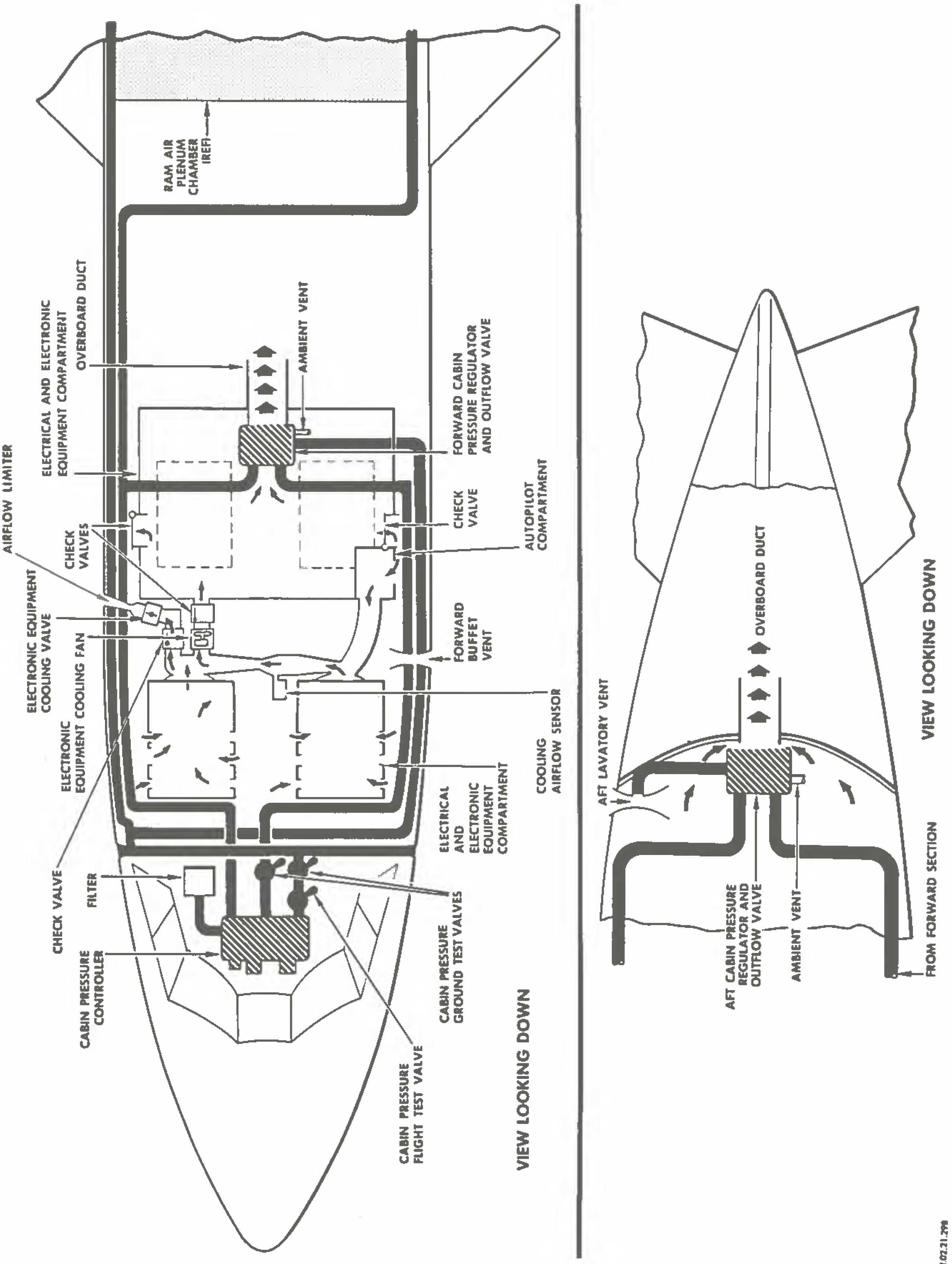
The pressurized and conditioned air, prior to being discharged through the forward outflow valve and electronic equipment cooling valve, is used to cool the electronic and electrical equipment compartment. See Figure 3.

For normal operation of the cabin pressure control system, the pressure regulator switches are placed in the AUTO position. This permits automatic (pneumatic)regulation when airborne. A ground safety relay connects the AUTO and OPEN position of each switch to electrically open the valves when on the ground. See Figure 4. The two valves are opened by separate circuits to minimize the possibility of having a pressurized cabin after landing.

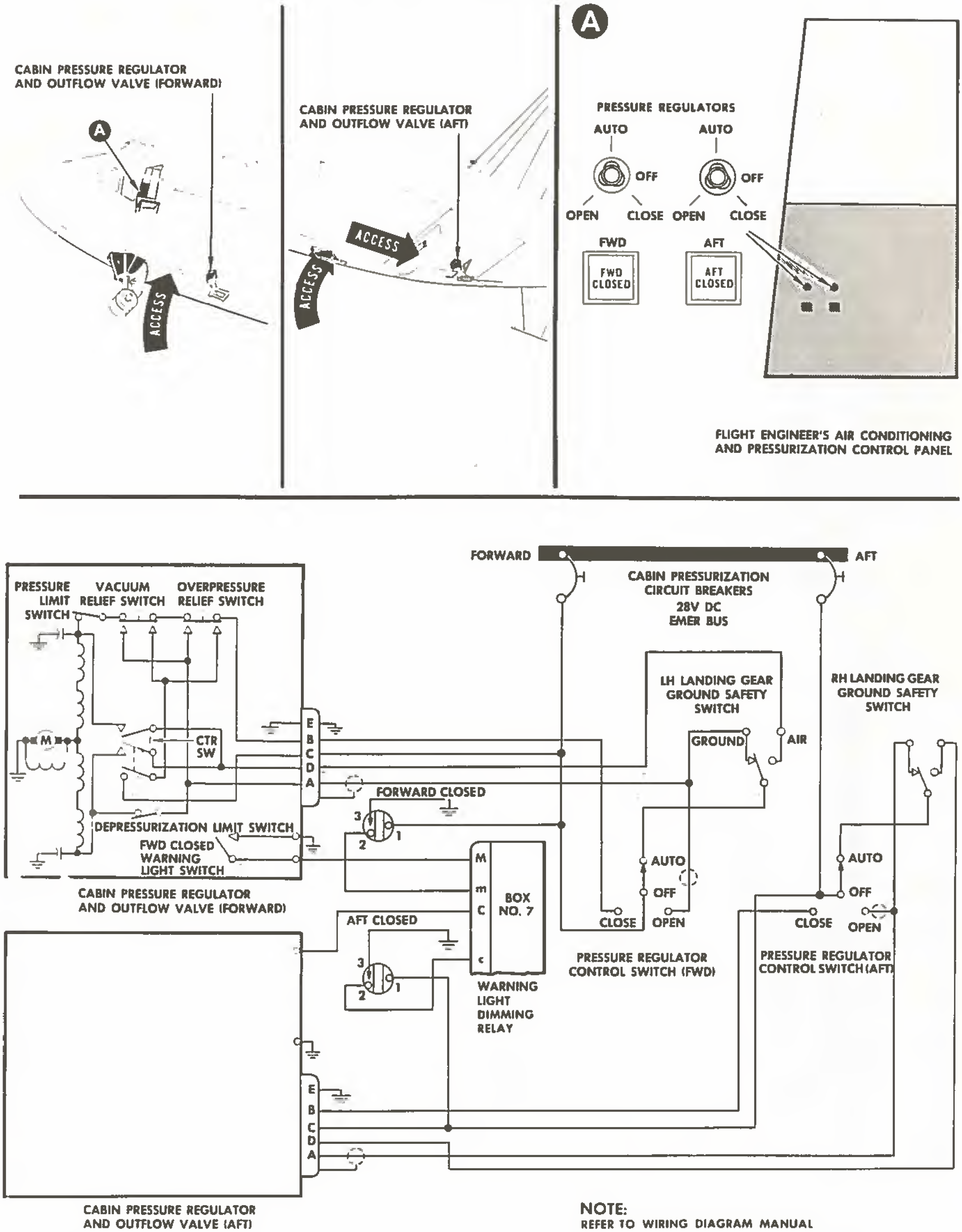


22.30.21.006 C •

Air Conditioning and
Pressurization Control Panel
Figure 2



Pressurization Control Valves and Vents
Figure 3



NOTE:
REFER TO WIRING DIAGRAM MANUAL
FOR FUSE AND CIRCUIT BREAKER AMPERAGE

22 30 21 0830

Pressurization Control Schematic (Electric)
Figure 4

PRESSURIZATION CONTROLS AND INDICATION - TROUBLE SHOOTING

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION
1. CABIN FAILS TO PRESSURIZE	
A. Cabin altitude selector knob improperly positioned.	Adjust cabin altitude selector knob to obtain pressurization.
B. Clogged filter on cabin pressure control or cabin pressure regulator and outflow valve.	Clean and replace filters on cabin pressure control and on both cabin pressure regulator and outflow valves.
C. Electrical malfunction.	Check security of electrical connections on outflow valve. Check wiring through manual control switch and landing gear ground safety relay. If proper voltage is presented at the connector of the outflow valve, and the valve cannot be controlled manually (electrically) replace the outflow valve.
D. Foreign object holding outflow valve open.	Check visually, and remove any obstruction.
E. Access door(s) not sealing properly.	Check that all doors are closed and sealing properly. Check particularly the nose wheel well access door for proper engagement of latching pins.
2. CABIN PRESSURE CONTROL SYSTEM FAILS TO MAINTAIN THE SELECTED CABIN ALTITUDE	
A. Clogged filter on cabin pressure control or on the cabin pressure regulator and outflow valves.	Clean and replace filter on the cabin pressure control and on both cabin pressure regulator and outflow valves.
B. Loose or damaged pneumatic tubing between cabin pressure control and the cabin pressure regulator and outflow valve.	Check security of tubing connections. Check tubing for leaks. (Do not pressure test tubing when connected to controller or to the outflow valves.)

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION

2. CABIN PRESSURE CONTROL SYSTEM FAILS TO MAINTAIN THE SELECTED CABIN ALTITUDE (CONT)

C. Obstructed lavatory vents.	Ascertain lavatory vents not obstructed by debris.

WARNING: MAINTENANCE PERSONNEL ARE LIMITED TO THE CORRECTIVE MEASURES LISTED ABOVE. DO NOT ATTEMPT TO MAKE ADJUSTMENTS ON THE BACK OF THE CABIN PRESSURE CONTROL OR ON THE CABIN PRESSURE REGULATOR AND OUTFLOW VALVES. IF THE ABOVE MEASURES DO NOT CORRECT THE MALFUNCTION, THE CABIN PRESSURE CONTROL OR THE OUTFLOW VALVES MUST BE REPLACED.

PRESSURIZATION CONTROLS AND INDICATION - MAINTENANCE PRACTICES

1. Adjustment/Test

A. General.

The following procedures are used to test the operation of several critical items in the pressurization control system which cannot be tested during normal flight operations. This test is also performed when any component of the pressurization control system is replaced, or when any structural components which may affect cabin pressurization have been replaced or repaired. Since most of the safety features in the pressurization system are duplicated, or backed up by another device, the failure of one item would not be detected by the flight crew. The airplane would not experience any trouble until the second similar failure occurred. The following tests will permit early detection of individual malfunctions, and they will prevent an accumulation of malfunctioning components which could eventually endanger the airplane and its occupants.

B. Equipment Required.

(1) An external source of air pressure capable of delivering approximately 50 pounds per minute airflow at 23.2 inches of mercury at a temperature not greater than 140 degrees F (60 degrees C). The rate of flow shall be adjustable from zero to full capacity. Pressure at airplane connection shall not be allowed to exceed 40 (±5) psig.

WARNING: THIS AIR WILL BE ROUTED THROUGH THE FREON EVAPORATOR WHERE TEMPERATURES IN EXCESS OF 170 DEGREES F (76.7 DEGREES C) ARE NOT PERMITTED. THIS LIMITATION APPLIES WHETHER THE FREON PACKAGE IS OPERATING OR NOT.

(2) External source of 115/200 volts, 400 cycle, three phase electrical power (refer to Chapter 24, ELECTRICAL POWER).

(3) A mercury manometer with connecting tubing for attachment to test connection in nose wheel well. Tubing must connect with an MS-21903D6 fitting in airplane.

(4) Intercom equipment for communication between persons inside and outside of the airplane.

(5) Caps to seal pressure sensing ports on cabin vertical speed indicator. (Caps must withstand 8.6 psig without leakage.)

(6) Warning signs to prevent unauthorized personnel from attempting to open doors while the airplane is pressurized.

CAUTION: THE DOORS WILL NOT OPEN UNDER PRESSURE, BUT A DETERMINED ATTEMPT MIGHT DAMAGE THE LOCKING MECHANISM.

(7) Plugs to seal the forward and aft lavatory and buffet vents.

C. Preparation.

(1) Install caps on pressure sensing ports on cabin vertical speed indicator (refer to Chapter 31, INSTRUMENTS).

(2) Install plugs in forward and aft lavatory and buffet vents.

(3) Connect mercury manometer to fitting and adjacent to CABIN PRESSURIZATION GROUND TEST valves in nose wheel well. (Adjust manometer if required.)

(4) Connect external source of electrical power to airplane (refer to Chapter 24, ELECTRICAL POWER).

(5) Place warning signs to keep unauthorized personnel away from airplane.

(6) Install and test intercom equipment to be used between the flight engineer's station and the person controlling the air pressure source.

(7) Connect air pressure source to bleed air manifold (fitting near right hand ram air inlet to air conditioning compartment).

WARNING: THIS AIR WILL BE ROUTED THROUGH THE FREON EVAPORATOR WHERE TEMPERATURES IN EXCESS OF 170 DEGREES F (76.7 DEGREES C) ARE NOT PERMITTED. THIS LIMITATION APPLIES WHETHER THE FREON PACKAGE IS OPERATING OR NOT. (SEE EQUIPMENT REQUIRED.)

(8) Place cabin pressurization ground test valve handles in RELIEF PRESS TEST position (both handles horizontal).

(9) Close forward and aft CABIN PRESS REG and ELEC COOLING VALVE circuit breakers.

(10) Place forward and aft PRESSURE REGULATOR switches (on flight engineer's control panel) in AUTO position.

(11) Place ELEC EQUIP COOLING VALVE switch in CLOSE position.

(12) Adjust cabin pressure controller to "0" cabin altitude.

WARNING: PRIOR TO PERFORMING STEP (13) FOLLOWING, ASCERTAIN THAT ANTI-SKID SYSTEM IS TURNED OFF AND/OR THE MAIN WHEELS ARE PROPERLY CHOCKED.

(13) Place RH and LH landing gear ground safety switches in airborne position (refer to Chapter 32, LANDING GEAR).

(14) With one or more persons inside to man the flight engineer's station, close all doors, windows and hatches.

D. General Procedures.

(1) During the pressurization procedure, one person shall monitor differential pressure from the flight engineer's control panel and a second person outside the airplane shall monitor differential pressure on the mercury manometer. Either person shall be prepared to reduce cabin pressure in an emergency.

WARNING: CABIN PRESSURE SHALL NOT BE ALLOWED TO EXCEED 8.6 PSIG (17.5 INCHES OF MERCURY).

(2) Because of its greater accuracy and reliability, the mercury manometer shall be used as the primary pressure measuring instrument. The differential pressure gauge on the flight engineer's control panel will serve as a backup.

(3) For the protection of persons working in the pressurized compartments pressure shall not be increased or decreased at rates in excess 1 psig (approximately 2 inches of mercury) per minute. The rate of change in pressure can be controlled by manually operating a pressure regulating outflow valve, or by varying the flow at the air pressure source.

WARNING: REVIEW COMPANY PROCEDURES AND SAFETY REGULATIONS CONCERNING WORK IN PRESSURIZED AREAS. KNOW IN ADVANCE THE PROCEDURE TO BE FOLLOWED IN THE EVENT OF AN INJURY FROM RAPID DECOMPRESSION. IF NO OTHER EQUIPMENT IS AVAILABLE, ANOTHER AIRPLANE CAN BE USED AS A COMPRESSION CHAMBER.

(4) Tests will be performed in the following sequence: pressurization leak test, a relief pressure test, which will check the pressure relief metering valve in both outflow valves, a differential test which will check the differential metering valve in the cabin pressure controller and a manual control test which checks electrical operation of the valve.

E. Leak Test.

(1) Open control valve on air pressure source and slowly increase pressure.

(2) Open either one of the emergency pressurization shutoff valves by placing the EMER PRESS SOURCE switch in the open position.

CAUTION: WHEN PRESSURE REACHES 1 PSIG (2 INCHES OF MERCURY) DETERMINE THAT BOTH THE DIFFERENTIAL PRESSURE GAGE AND THE MERCURY MANOMETER REGISTER PRESSURE. IF THEY DO NOT AGREE REDUCE PRESSURE AND CHECK INSTRUMENTATION.

(3) Regulate air pressure source to keep the rate of cabin pressure increase below 1 psig per minute (2 inches of mercury). If required, a pressure regulating outflow valve may be manually opened and then closed as pressure increases.

NOTE: If cabin temperature becomes uncomfortably warm, the Freon package on the side corresponding to the open emergency pressurization valve may be placed in operation.

(4) As cabin pressure increases, it may be necessary to open the second emergency pressurization shutoff valve. To do so, place the other EMER PRESS SOURCE switch in the open position.

(5) When airplane is pressurized to 15 inches of mercury, turn off source of air supply and allow pressure to decrease normally.

(6) When pressure decreases to 11.4 inches of mercury, begin timing pressure drop with stop watch; time lapse for pressure to drop from 11.4 to 6.1 inches of mercury shall be a minimum of four minutes and 10 seconds.

(7) If pressure drops from 11.4 to 6.1 inches of mercury in less than the time specified in step (6), proceed as follows:

(a) Pressurize airplane with air supply adjusted to maintain pressure at 11.4 inches of mercury.

(b) Check for leaks using bubble fluid around suspected leakage areas.

(c) Repair leaks as required (refer to applicable chapter in Maintenance Manual containing repair information on windows, doors, seals, structure etc.).

(d) When leaks have been repaired, pressurize and retest airplane per steps (5) through (7). When test is satisfactory, remove plugs from lavatory and buffet vents and proceed to relief and differential pressure tests.

F. Relief and Differential Pressure Test.

(1) Slowly increase air supply and attempt to pressurize airplane to 17.5 inches of mercury (8.6 psig).

(2) As cabin pressure differential approaches 8.5 psi (17.3 inches of mercury) determine that both PRESSURE REGULATOR switches are in the AUTO position.

CAUTION: THE FORWARD AND AFT PRESSURE REGULATING OUTFLOW VALVES SHOULD OPEN AT 8.5 (±0.1) PSIG (17.3 (±0.2) INCHES OF MERCURY). CHECK FOR AIR FLOW FROM BOTH VALVES. IF ONE VALVE OPENS AT THE LOWER LIMIT, IT MAY BE IMPOSSIBLE TO INCREASE PRESSURE TO THE UPPER LIMIT. IF THIS HAPPENS, MANUALLY CLOSE ONLY THE OPEN VALVE TO BRING PRESSURE UP TO 8.6 PSIG (17.5 INCHES OF MERCURY). NEVER EXCEED 8.6 PSIG (17.5 INCHES OF MERCURY). A PRESSURE REGULATING OUTFLOW VALVE THAT FAILS TO OPEN AT THE UPPER LIMIT PRESSURE SHALL BE REPLACED.

(3) While maintaining cabin pressure, place the cabin pressurization ground test valve handles in the DIFFERENTIAL TEST position (left handle horizontal, right handle vertical).

(4) Cabin pressure shall decrease and stabilize at 8.30 psi (16.9 inches of mercury).

(5) With both emergency pressure source switches OPEN, and the air pressure source delivering full capacity, it should be impossible to increase cabin pressure above 8.30 (±0.1) psi (16.9 (±0.2) inches of mercury). If cabin pressure exceeds these limits the cabin pressure controller shall be replaced. If a new controller does not correct the trouble, a leak is indicated in the control tubing from the cabin pressure controller to the pressure regulating outflow valves.

NOTE: Check cabin altimeter and cabin differential pressure indicator for the following indications:

(a) Cabin altimeter shall "peg out".

(b) Cabin differential pressure indicator shall indicate 8.0 to 8.6 (±0.2) psig.

(6) Slowly reduce cabin pressure to zero differential.

CAUTION: DO NOT REDUCE CABIN PRESSURE AT A RATE IN EXCESS OF 1 PSIG PER MINUTE. (APPROXIMATELY 2 INCHES OF MERCURY PER MINUTE)

(7) Place both cabin pressure ground test valves in the FLIGHT position (both handles vertical). Lock wire handles in FLIGHT position.

(8) Correct barometric pressure on cabin pressure controller to read sea level pressure prevailing at time of test, then adjust cabin altitude control knob to minus 1,000 feet.

(9) Slowly turn on the air pressure source. Cabin pressure shall increase to approximately 0.5 psi (1 inch of mercury).

(10) Place LH and RH landing gear ground safety switches in ground position (refer to Chapter 32, LANDING GEAR).

(11) Slowly adjust cabin altitude control knob to zero altitude. Cabin pressure shall decrease to a maximum of 0.15 psig (0.3 inch of mercury). If cabin pressure remains above this limit, the cabin pressure controller (located on flight engineer's control panel) shall be replaced.

G. Outflow Valve and Warning Light Test.

(1) With the airplane depressurized and air pressure source turned off, place and hold PRESSURE REGULATOR switches in CLOSE position and check for the following:

(a) Forward and aft outflow valves shall close (check position indicators on valves).

(b) FWD and AFT CLOSED warning lights shall illuminate.

(2) Place FWD PRESSURE REGULATOR switch in AUTO position and check for the following:

(a) Forward outflow valve shall open within 14 to 35 seconds.

(b) FWD CLOSED warning light shall extinguish.

(3) Place FWD PRESSURE REGULATOR switch in OPEN position; there shall be no change in results from step (2).

(4) Place FWD PRESSURE REGULATOR switch in CLOSE position.

(a) Forward outflow valve shall close within 14 to 35 seconds.

(b) FWD CLOSED warning light shall illuminate.

(5) Repeat steps (2) through (4) substituting AFT for FWD and aft for forward.

<u>WARNING</u>: PRIOR TO PERFORMING STEP (6) ASCERTAIN THAT ANTI-SKID SYSTEM IS TURNED OFF AND/OR THE MAIN WHEELS ARE PROPERLY CHOCKED.

(6) With FWD and AFT PRESSURE REGULATOR switches in CLOSE position place LH and RH landing gear ground safety switches in airborne position (refer to Chapter 32, LANDING GEAR).

(a) Forward and aft outflow valves shall remain closed.

(b) FWD and AFT CLOSED warning lights shall remain illuminated.

(7) Place FWD PRESSURE REGULATOR switch in AUTO position.

(a) Forward outflow valve shall remain closed.

(b) FWD CLOSED warning light shall remain illuminated.

(8) Place FWD PRESSURE REGULATOR switch in OPEN position.

(a) Forward outflow valve shall open.

(b) FWD CLOSED warning light shall extinguish.

(9) Place FWD PRESSURE REGULATOR switch in CLOSE position.

(a) Forward outflow valve shall close.

(b) FWD CLOSED warning light shall illuminate.

(10) Repeat steps (7) through (9) substituting AFT for FWD and aft for forward.

(11) Place LH and RH landing gear ground safety switches in groundborne position.

(12) When test is complete remove caps and connect tubing to the cabin vertical speed indicator.

(13) Remove mercury manometer connection in nose wheel well. (Cap airplane fitting.)

(14) Remove air pressure source and electrical power from airplane.

(15) Remove warning signs.

2. Leak Test Cabin Pressure Regulating and Outflow Valves and Cabin Pressure Controller Static Sensing System

A. Equipment Required.

(1) Pitot-static test stand.

(2) Bubble fluid.

(3) Pressure caps capable of withstanding 150 psi.

B. Leak Test Cabin Pressure Regulating and Outflow Valves Static Sensing System.

NOTE: The leak test for the cabin pressure regulating and outflow valves is accomplished when testing the autopilot static system. Refer to Chapter 34, NAVIGATION, for procedure.

C. Leak Test Cabin Pressure Controller Static Sensing System.

(1) Disconnect tubing from forward venturi; venturi is on right side of forward cargo compartment.

(2) Connect vacuum line from pitot-static test stand to tubing disconnected in step (1); connect test stand line to tubing which connects venturi to cabin pressure controller.

(3) Remove cabin pressure controller air filter (refer to 21-2-1, Maintenance Practices). Cap end of filter line at point where air filter was disconnected.

(4) Rotate CABIN ALT control knob on cabin pressure controller until cabin altitude dial indicates 10,000 feet.

(5) Adjust RATE control knob on cabin pressure controller to full INC (extreme clockwise) position.

CAUTION: IN STEP (6) DO NOT EXCEED A RATE OF CLIMB OVER 5,000 FEET PER MINUTE.

(6) Slowly apply a vacuum of 10.0 inches of mercury (19.92 inches of mercury, absolute).

(7) When vacuum stabilizes at 10.0 inches of mercury, shut off vacuum source at test stand. Allow system to remain with this vacuum for a minimum of three minutes.

(8) Vacuum loss shall not exceed 0.50-inch of mercury during three minute test period.

NOTE: If indicated leakage rate exceeds 0.50-inch of mercury during test period, slowly reduce system to 0 inch of mercury (atmosphere) and disconnect test stand vacuum line from airplane tubing. Connect test stand pressure line to airplane tubing and pressurize system to 5.00 inches of mercury (34.92 inches of mercury absolute); use bubble fluid to locate leaks.

(9) Repair leaks as necessary. When all leaks are repaired remove test stand pressure line from airplane tubing and reconnect test stand vacuum line to same tubing; retest system per steps (6) through (8).

CAUTION: IN STEP (10) DO NOT EXCEED A RATE OF DESCENT OVER 5,000 FEET PER MINUTE.

(10) When system proves satisfactory slowly reduce test stand vacuum to 0 inch of mercury (atmosphere).

(11) Remove pitot-static test stand line from venturi in forward cargo compartment; connect airplane system tubing to venturi.

(12) Remove cap from cabin pressure controller air filter line and install air filter (refer to 21-2-1, Maintenance Practices).

CABIN PRESSURE CONTROLLER - DESCRIPTION AND OPERATION

1. Description

The cabin pressure controller is used in conjunction with two cabin pressure regulating outflow valves to control cabin pressure. It controls the cabin pressure regulator and outflow valves by varying a reference pressure transmitted to the pneumatic relay in each valve.

The cabin pressure controller, shown on Figure 1, is located on the lower left side of the flight engineer's control panel. Three indicators and three control knobs are incorporated in the controller. The main dial and pointer indicate the selected cabin altitude within the range of minus 1,000 to plus 10,000 feet. The small inner dial at the top indicates the maximum flight altitude at which the selected cabin altitude can be maintained. The dial in the upper right side is the barometric correction scale, and is calibrated in inches of mercury. The three control knobs are the cabin altitude control, the barometric correction control, and the rate control.

The cabin altitude control knob is used to set the desired cabin altitude on the main dial. The barometric control is set at the local altimeter setting prior to take off or landing. The rate control knob is used to establish the rate of climb or descent in cabin altitude. The rate control knob can be set to maintain any rate between 50 and 2,000 feet per minute.

2. Operation

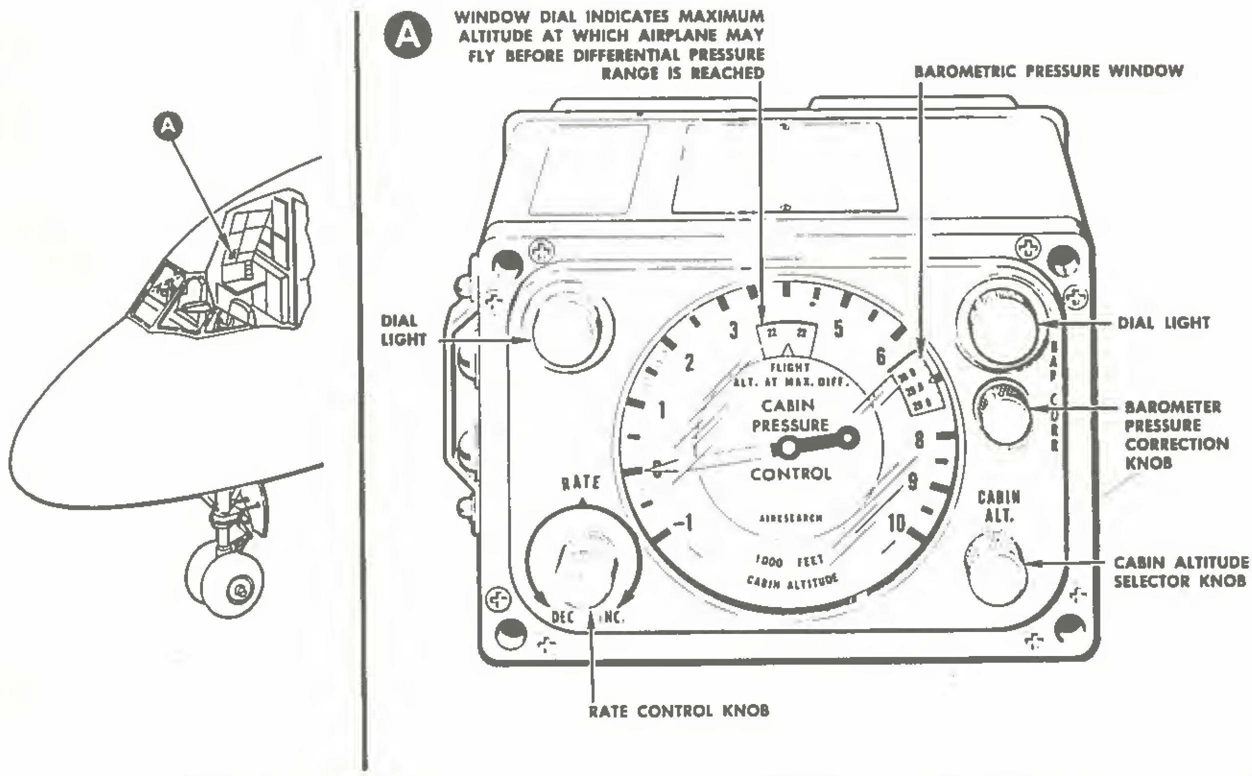
The cabin pressure controller has three separate pressure controlling systems or modes of operation. They are a selective pressure rate of change, a variable isobaric, and a fixed differential pressure system. These systems operate one at a time to establish the reference pressure, and the transition from one to another is automatic.

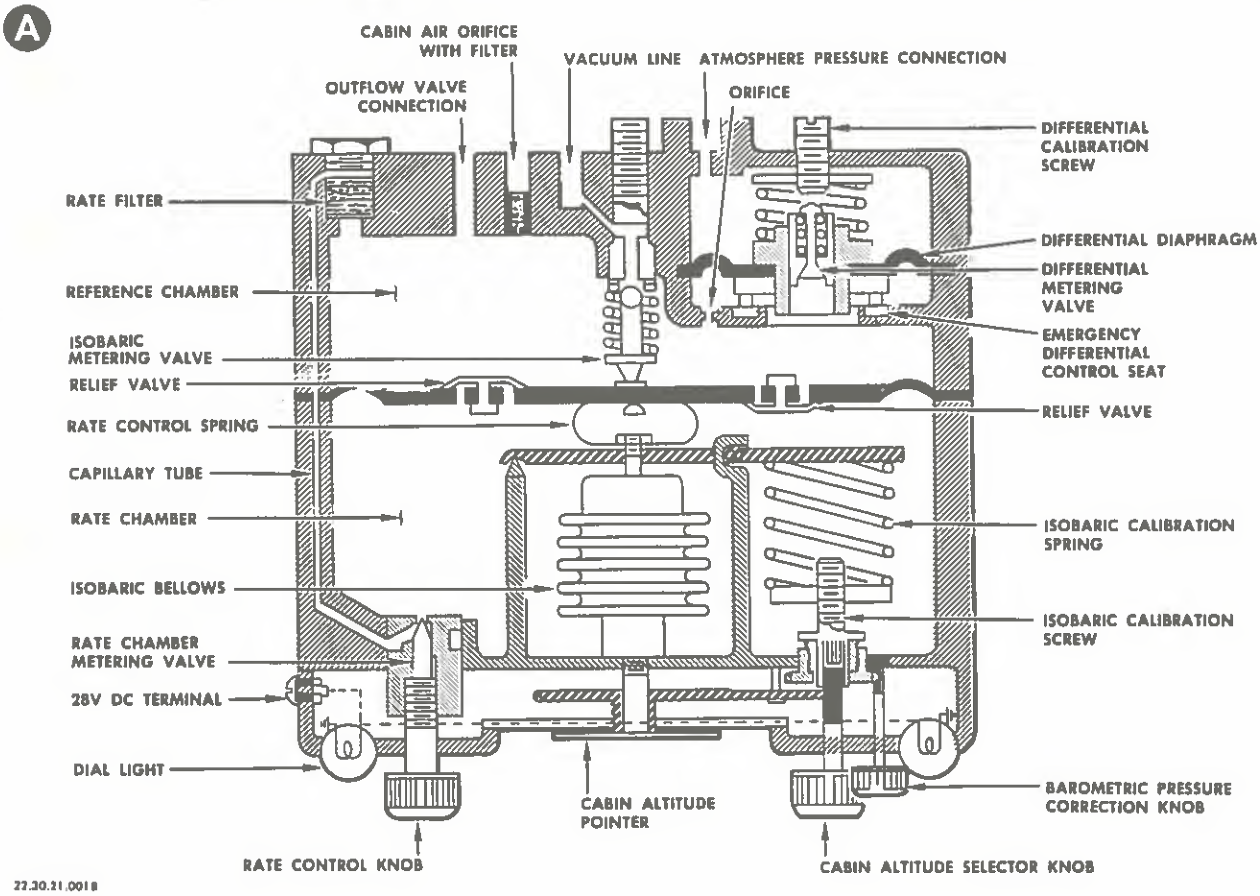
A. Selective Pressure Rate-of-Change Control.

The selective pressure rate-of-change control system consists of the rate control spring, a rate control diaphragm which separates the housing into two chambers, and a connecting drilled passage with filter, capillary tube, and rate chamber metering valve.

B. Isobaric Control.

The variable isobaric control system consists of an evacuated isobaric bellows and rocker arm which are connected to an isobaric metering valve through a rate control spring. An isobaric calibration spring and isobaric calibration screw are secured to the rocker arm, and are indexed to a cabin altitude pointer through a gear train.





Cabin Pressure Controller
Figure 1

C. Fixed Differential Control.

The fixed differential control system consists of a spring-loaded differential diaphragm, a differential metering valve and a differential calibration screw. One side of the differential diaphragm is vented to atmospheric pressure and the other side of the differential diaphragm is exposed to reference pressure. This system also incorporates a fail safe feature consisting of an emergency differential control seat and orifice.

D. Barometric Pressure Correction.

The barometric pressure correction mechanism consists of a barometric pressure correction knob, a gear train linked to the variable isobaric control spring, and a window dial calibrated over a range of 28.0 to 31.0 inches of mercury absolute.

E. Control Operation - Rate of Change.

Before control operation, pressures on both sides of the rate control diaphragm are equalized at existing atmospheric pressure. This compresses the isobaric bellows and opens the isobaric metering valve. Cabin air then flows into the reference chamber through the cabin air filter and orifice, and out through the isobaric metering valve to atmosphere. Pressure in the reference chamber is sensed by the outflow valve, which then operates according to the cabin-to-airplane altitude graph to produce an essentially unpressurized cabin, provided the rate of ascent of the aircraft does not exceed the selected rate. If the airplane rate of climb exceeds the selected rate, reference pressure is reduced, resulting in a pressure differential across the rate control diaphragm because of the capillary tube and rate chamber metering valve position. The rate control diaphragm then moves the isobaric metering valve to limit flow of air from the reference chamber until reference pressure and rate pressure equalize. The outflow valve reacts to control the rate of change of cabin pressure accordingly.

F. Control Operation - Isobaric Range.

As the airplane enters the isobaric operating range, the isobaric bellows expands sufficiently to override the rate control diaphragm and assume control of the isobaric metering valve. With reference chamber pressure maintained essentially constant by the isobaric bellows and metering valve, reference pressure in the outflow valve remains constant. Variations in cabin pressure act directly to position the outflow valve, controlling cabin pressure at selected altitude.

G. Control Operation - Differential Range.

The differential control serves to limit reference pressure in order that the outflow valve will establish an essentially constant pressure differential between cabin and atmosphere. As the airplane enters the differential operating range, the pressure differential between reference chamber and atmosphere allows the differential diaphragm to open the differential metering valve and release reference chamber air to atmosphere. The fail safe feature prevents loss of reference pressure in the event of a ruptured differential diaphragm by sealing the differential diaphragm from the reference chamber, permitting only a small loss of reference chamber air through the orifice. During a rapid descent, the differential metering valve closes because of increased atmospheric pressure. If the resultant rate of increase in reference pressure exceeds the selected rate, the rate control diaphragm moves the isobaric metering valve to a metering position and air from the reference chamber is bled to atmosphere. The outflow valve reacts to the reference pressure by limiting the rate of increase in cabin pressure.

Prior to landing, the cabin altitude selector is set to the altitude of the destination airport. Barometric pressure correction, indicated in the right hand window of the control dial face is set by turning the barometric pressure correction (BAR CORR) knob. Turning the correction knob rotates the gear train which changes the isobaric calibration spring tension and corrects the unit to the barometric pressure at the flight destination.

CABIN PRESSURE CONTROLLER - MAINTENANCE PRACTICES

1. Removal/Installation Cabin Pressure Controller (see Figure 201)

A. Remove Cabin Pressure Controller.

(1) Open FLT ENGR PNL LTS circuit breaker.

(2) Release Camloc fasteners and open flight engineer's control panel for access to controller mounting bracket (refer to Chapter 31, INSTRUMENTS).

(3) Disconnect four tubing connections just below cabin pressure controller. (Avoid bending or twisting the tubing; cap ends of tubing.)

(4) Disconnect two electrical leads from left side of controller. (Tag for installation.)

(5) Release four Camloc fasteners which secure controller mounting bracket to airplane structure. (The two left hand fasteners are on the front of the bracket, and the two right hand fasteners are on the side.)

(6) Remove mounting bracket, controller and cabin altimeter as a unit.

(7) Remove four short pieces of tubing connected to rear of controller. (Cap and tag each piece of tubing for identification upon installation; cap connections on controller.)

(8) Remove four mounting screws and separate controller from mounting bracket.

B. Install Cabin Pressure Controller.

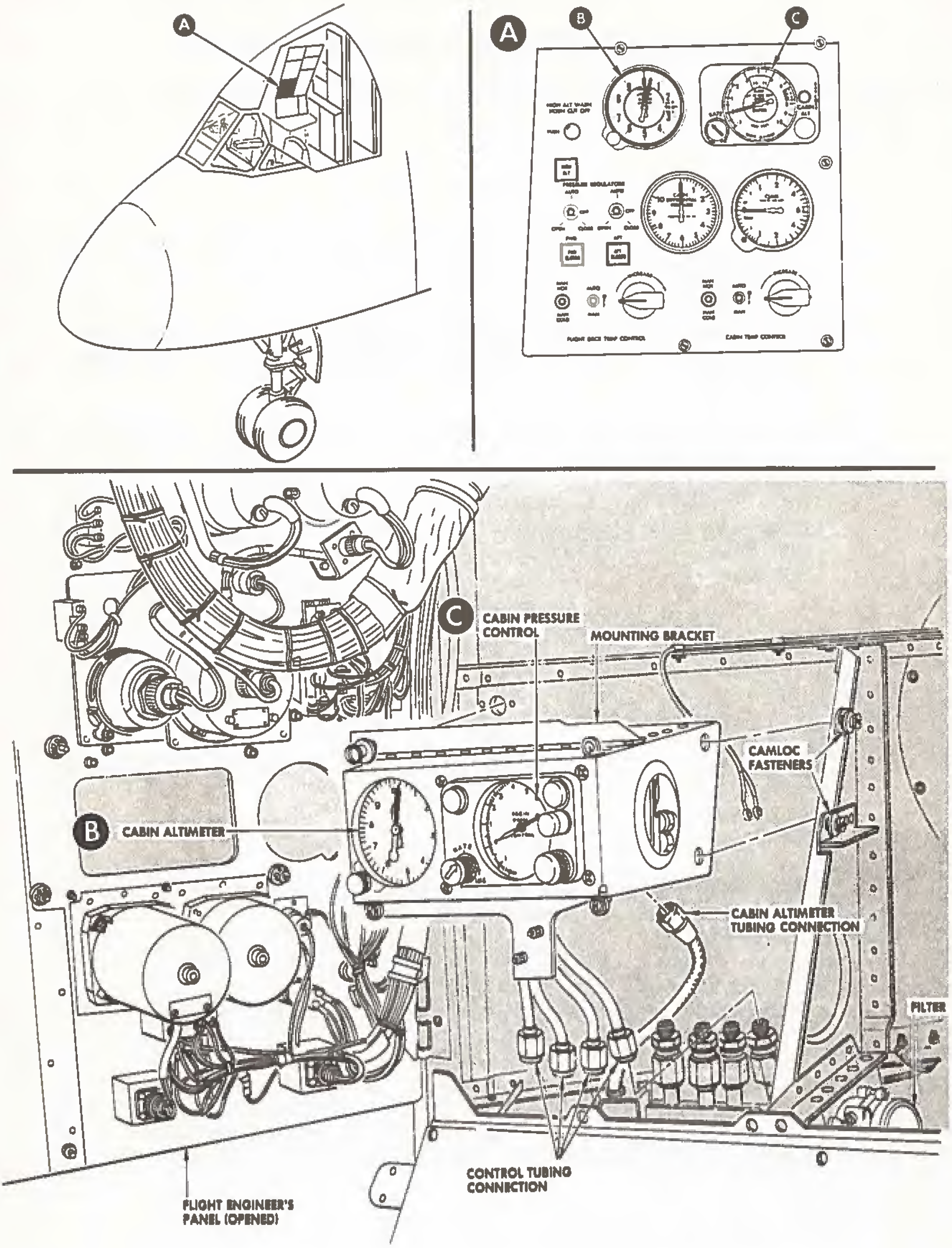
(1) Position cabin pressure controller in mounting bracket and secure with four mounting screws.

(2) Install four short pieces of tubing on rear of controller.

NOTE: The open ends of the four pieces of tubing will be close together and will point downward to mate with connections just below controller mounting position.

(3) Position and fasten mounting bracket to airplane structure with four Camloc fasteners. (The two left hand fasteners are on the front of the bracket, and the two right hand fasteners are on the side.)

(4) Connect two electrical leads to left side of controller.



22.02.21.155

Removal of Cabin Pressure Controller
Figure 201

TEMPORARY REVISION NO. 21-16.

Insert facing 21-2-1, Page 202 dated Dec. 5/60. This temporary revision supersedes Temporary Revision No. 21-13.

Page 202; delete CABIN ALTIMETER TUBING CONNECTION callout at lower right corner of art.

Page 202; show flexible line connected to back side of cabin differential pressure gage. (Differential pressure gage is the gage second from the left on the panel shown in open position.) This line does not have to be disconnected to remove the cabin pressure controller.

(5) Connect four pieces of tubing to fittings just below cabin pressure controller. (Avoid twisting or bending the tubing.)

NOTE: Tubing connections below controller are stencilled to prevent improper connection.

(6) Close flight engineer's panel (refer to Chapter 31, INSTRUMENTS).

(7) Close FLT ENGR PNL LTS circuit breaker.

(8) Perform Adjustment/Test in 21-2-0, PRESSURIZATION CONTROLS AND INDICATION.

2. Removal/Installation Cabin Pressure Controller Air Filter (see Figure 201)

A. Equipment Required - None.

B. Remove Cabin Pressure Controller Air Filter.

(1) Open FLT ENGR PNL LTS circuit breaker.

(2) Release Camloc fasteners and open flight engineer's control panel for access to filter. Filter is located slightly below and to the right of the cabin pressure controller.

(3) Disconnect tubing connection on back side of filter housing. (Cap open tubing.)

(4) Loosen clamp securing filter housing to mounting bracket and remove filter housing.

(5) Replace filter element and clean filter housing and orifice (refer to Chapter 12, SERVICING).

C. Install Cabin Pressure Controller Air Filter.

(1) Place filter housing in mounting bracket and secure with clamp.

(2) Connect and tighten tubing to fitting on back side of filter housing.

(3) Close and secure flight engineer's control panel.

(4) Close FLT ENG PNL LTS circuit breaker.

CABIN PRESSURE REGULATOR AND OUTFLOW VALVE - DESCRIPTION AND OPERATION

1. General

Two cabin pressure regulator and outflow valves are installed to maintain the desired pressure level within the airplane and are illustrated on Figure 1. The two valves control the pressurization level, or cabin altitude by regulating the amount of air exhausted from the pressurized compartments. They also serve as pressure relief, vacuum relief, and dump valves.

The forward outflow valve is located on the floor of the electrical compartment, and the aft outflow valve is located below the aft lavatory. Both valves are mounted on short transition ducts which adapt the circular valve outlets to rectangular discharge ports in the fuselage skin. The two valves are identical except for a coarse screen which is wrapped around the forward valve. The screen will prevent the electrical compartment curtain from being sucked into the valve assembly should the curtain come loose. Primary control of both valves is maintained by the cabin pressure controller on the flight engineer's control panel.

When the PRESSURE REGULATORS control switches are placed in the AUTO position, the operation of the pressure regulator and outflow valves is completely pneumatic. When operated manually, an electric motor is used to position the outflow valve. If the valves are closed electrically the pressure and vacuum relief functions also require electric power. Many fail-safe features are incorporated in the design of the cabin pressure control subsystem. When operating in the automatic mode, a failure of one valve to the closed position will cause no change in pressurization because the other valve has the capacity to regulate the entire outflow. If both valves fail to the closed position, the pressure and vacuum relief functions will still operate. If one or both valves fail to the open position, a cabin pressure limiting device will close the valves enough to maintain a cabin altitude of 13,000 (±2,000) feet. Any single failure of either or both valves will not endanger the occupants or structural integrity of the airplane.

If two failures occur in one valve, such as a failure to the closed position and a failure of the pressure relief function - the manual controls are still available to override the pneumatic system. Another safety feature is included in the wiring installation to prevent accidental dumping of cabin pressurization by a short circuit. The "manual open" control circuit is completely shielded with a grounded metallic sheath. The sheath will ground any "hot" wires that might come in contact with this critical wiring, and will actuate the appropriate overload protection to remove the power. Terminal connections on the manual control switches are "potted" to further reduce the possibility of trouble.

2. Description

The cabin pressure regulator and outflow valve is a double acting, pneumatically actuated poppet valve with a motor driven override for manual control. In automatic operation, the valve regulates the amount of air exhausted from the pressurized compartments to maintain the cabin pressure

programmed by the cabin pressure controller. If the pressure differential reaches 8.50 psi, the outflow valve will open to serve as a pressure relief valve. A vacuum of 0.36 psi will also open the outflow valve to equalize the pressure.

The outflow valve is approximately 9 inches in diameter, and when fully open, it has an effective flow area of 29.5 square inches.

3. Operation

When operated in the automatic mode (pneumatic), the position of the outflow valve is determined by cabin and ambient pressure opposing a reference pressure and a poppet valve return spring (see Figure 1). Both cabin pressure and ambient pressure tend to force the valve toward the open position. The poppet valve return spring provides a constant closing force. This leaves the reference pressure as the main variable for control purposes. When reference pressure is increased, the outflow valve is moved toward the closed position to restrict the cabin outflow. This leads to a corresponding increase in cabin pressure. Decreasing reference pressure will allow the outflow valve to move toward the open position and will decrease cabin pressure.

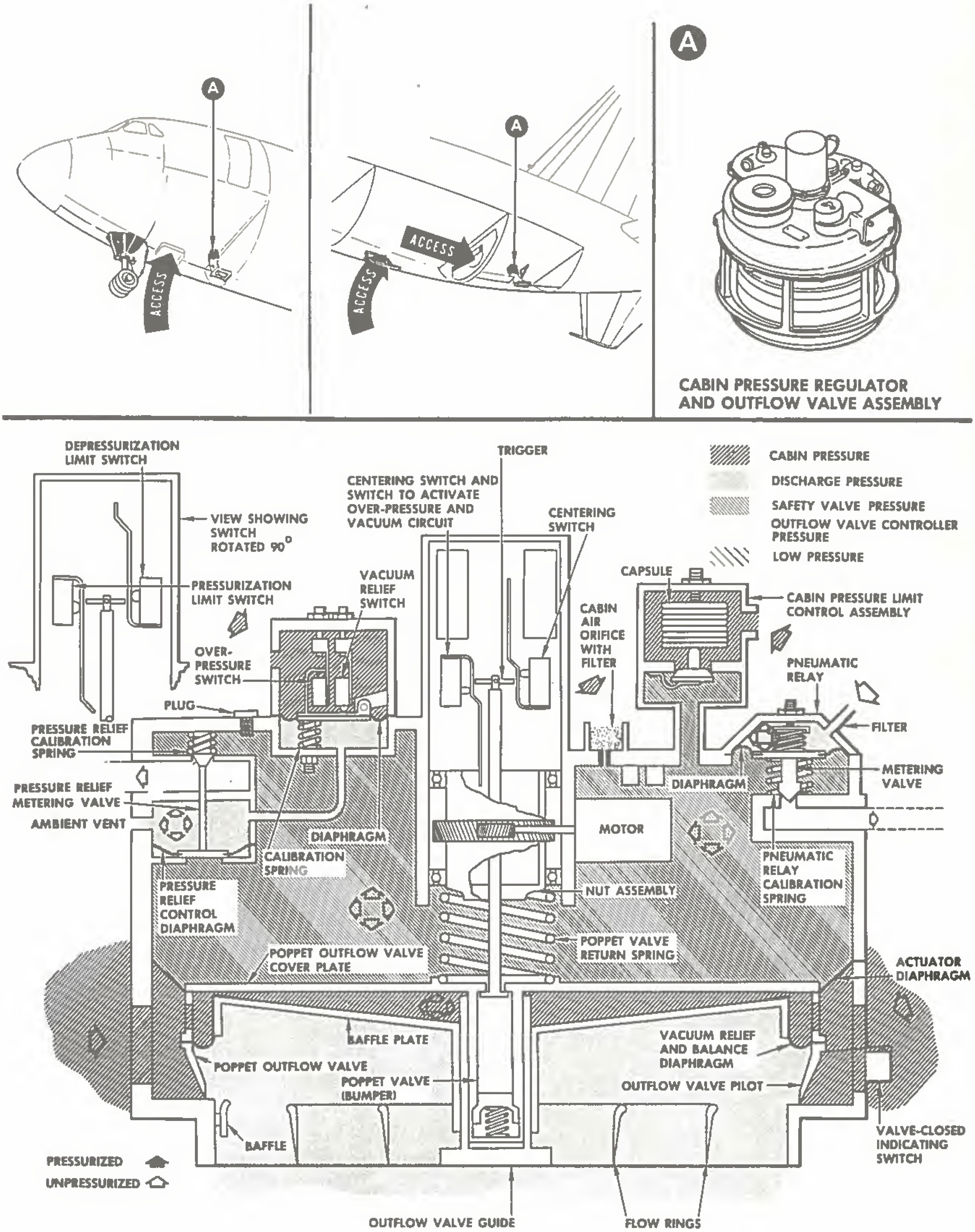
A. Reference Pressure.

In order to permit automatic pneumatic operation of the cabin pressure limiting controls, a reference pressure which is slightly below cabin pressure must be established. This reference or low pressure is created by venturi tubes through which lavatory ventilating air is passed. There are four control devices shown in Figure 1 which can affect the reference pressure. They are, from left to right, the pressure relief metering valve, cabin air orifice, cabin pressure limit control, and the pneumatic relay.

B. Reference Pressure Control

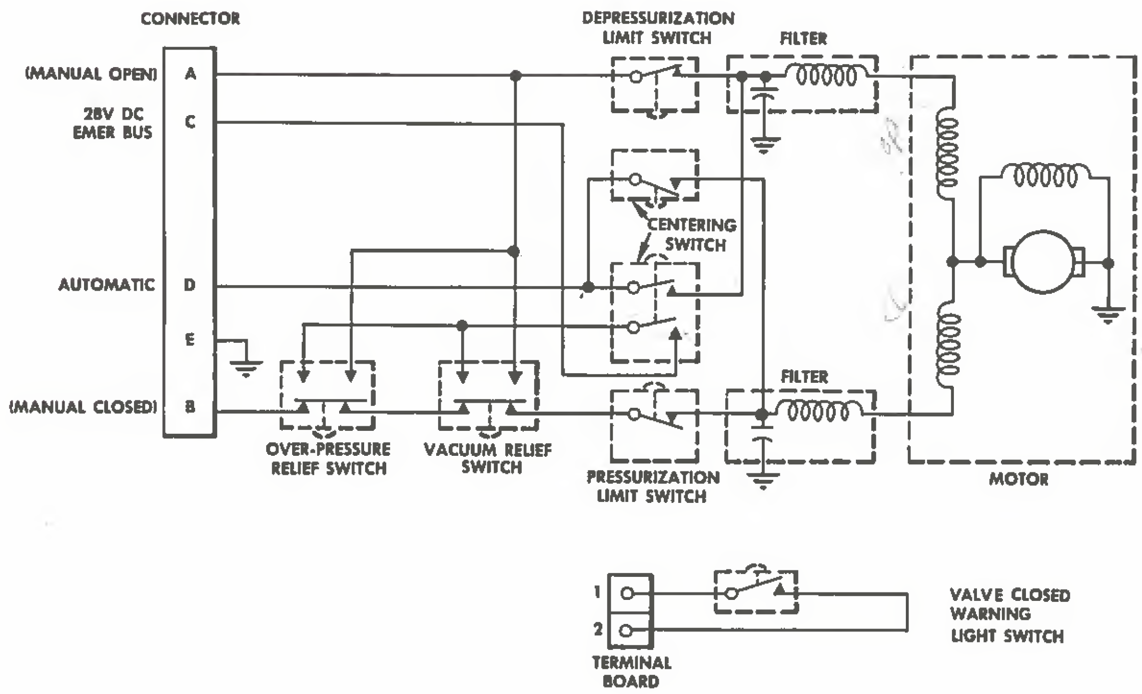
The pressure relief metering valve is actuated by a diaphragm which limits reference pressure in relation to ambient pressure. This is a safety feature to prevent excessive reference pressure from holding the outflow valve closed, and thus destroying the pressure relief function. The pressure relief metering valve will limit cabin pressure to 8.50 (±0.1) psig.

The cabin air pressure is admitted to the reference chamber through a calibrated orifice. The incoming air passes through a filter designed to remove dust and tobacco smoke. This prevents dirt and tar accumulations that might clog the orifice or cause moving parts of the valve assembly to stick. The pneumatic relay works in conjunction with the cabin air orifice to maintain the desired reference pressure. Acting on a pneumatic signal from the cabin pressure controller the pneumatic relay controls reference pressure by regulating the amount of air vented to the vacuum line.



30.30.21.016A

Cabin Pressure Regulator and Outflow Valve
Figure 1 (Sheet 1 of 2)



Cabin Pressure Regulator and Outflow Valve
Figure 1 (Sheet 2 of 2)

The cabin pressure limit control assembly is calibrated to limit cabin altitude to 13,000 (±2,000) feet. It contains a sealed capsule and a normally closed poppet valve. When cabin pressure decreases to the calibrated value, the sealed capsule will expand and open the poppet valve. This will allow cabin pressure to flow into the reference chamber and close the outflow valve poppet.

Since the forward outflow valve is contained within the electrical compartment, its operation depends upon the pressure sensed in the electrical compartment. When the electronic cooling valve is opened, electrical compartment pressure is reduced. This will have the same effect on the forward outflow valve as an excessively high cabin altitude, and will cause the valve to move toward the closed position. The forward outflow valve will, in normal operation, remain closed or nearly closed because the electronic cooling valve will exhaust most of the air. If the aft outflow valve is closed by a malfunction, then the forward outflow valve will automatically open to regulate cabin pressure for the entire airplane.

C. Manual Outflow Valve Operation.

The outflow valve may be positioned manually by means of an electric motor which will override all of the previously mentioned pneumatic controls. The control switch which controls the motor operation has four positions labeled AUTO, OFF, OPEN, and CLOSED. The OPEN and CLOSED positions are spring-loaded for momentary use, and can be used to place the outflow valve in any position. Holding the switch in the OPEN position will apply 28-volt dc power to terminal A of the valve assembly; see Sheet 2 of Figure 1. The motor will turn in the direction that raises the jackscrew, and this will open the outflow valve. When the jackscrew reaches the limit of its travel, the depressurization limit switch is opened to prevent damaging the mechanism; see Sheets 1 and 2 of Figure 1. In a similar manner, power applied to terminal B will close the outflow valve. Travel in this direction is limited by the pressurization limit switch.

D. Automatic Outflow Valve Operation.

For automatic operation of the outflow valve, power is applied to terminal D. If the jackscrew is in the center position, no action will take place. If the jackscrew is not centered, the appropriate centering switch will energize the motor and run it in the direction necessary for centering. It will stop with the jackscrew centered to permit automatic (pneumatic) operation.

Terminal C is energized at all times to permit the over-pressure and vacuum relief switches to operate. When the jackscrew is anywhere between the center position and the closed (down) position, the centering switch will connect terminal C to the over-pressure and vacuum relief switches. Then, if pressure or vacuum relief is required, the appropriate switch will route 28-volt dc power to the motor and drive the jackscrew back to the center position.

E. Valve Closed Warning Light Switch.

Each pressure regulating outflow valve contains a switch which controls the operation of its respective VALVE CLOSED warning light. The switch contacts are closed when the outflow valve poppet is within 1/32 of an inch of the closed position.

CABIN PRESSURE REGULATOR AND OUTFLOW VALVE - MAINTENANCE PRACTICES

1. Removal/Installation Cabin Pressure Regulator and Outflow Valve (see Figure 201.)

   A. General.

      (1) Access to the forward pressure regulating outflow valve is obtained through the electrical and electronics compartment door.

      (2) Access to the aft pressure regulating valve is obtained through the zippered lining at the aft bulkhead of the aft cargo compartment.

   B. Remove Cabin Pressure Regulator and Outflow Valve.

      (1) Open FWD and AFT CABIN PRESS REG circuit breakers. Place warning tags on open circuit breakers.

      (2) Disconnect pneumatic tubing at connection to outflow valve. (Cap tubing and valve ports and tag tubing for installation.)

      (3) Loosen other end of each piece of tubing so that they can be rotated. This will permit valve removal without bending the tubing.

      (4) Remove screws and clips securing wiring harness to outflow valve. (Bag and tag for installation.)

      (5) Disconnect two wires from terminal strip on side of outflow valve. (Tag for installation.)

      (6) Disconnect electrical connector from receptacle on top of valve. (Cap and tag for installation.)

      (7) Disconnect Marman clamp from base of valve.

      (8) Remove pressure regulating outflow valve and gasket.

   C. Install Cabin Pressure Regulator and Outflow Valve.

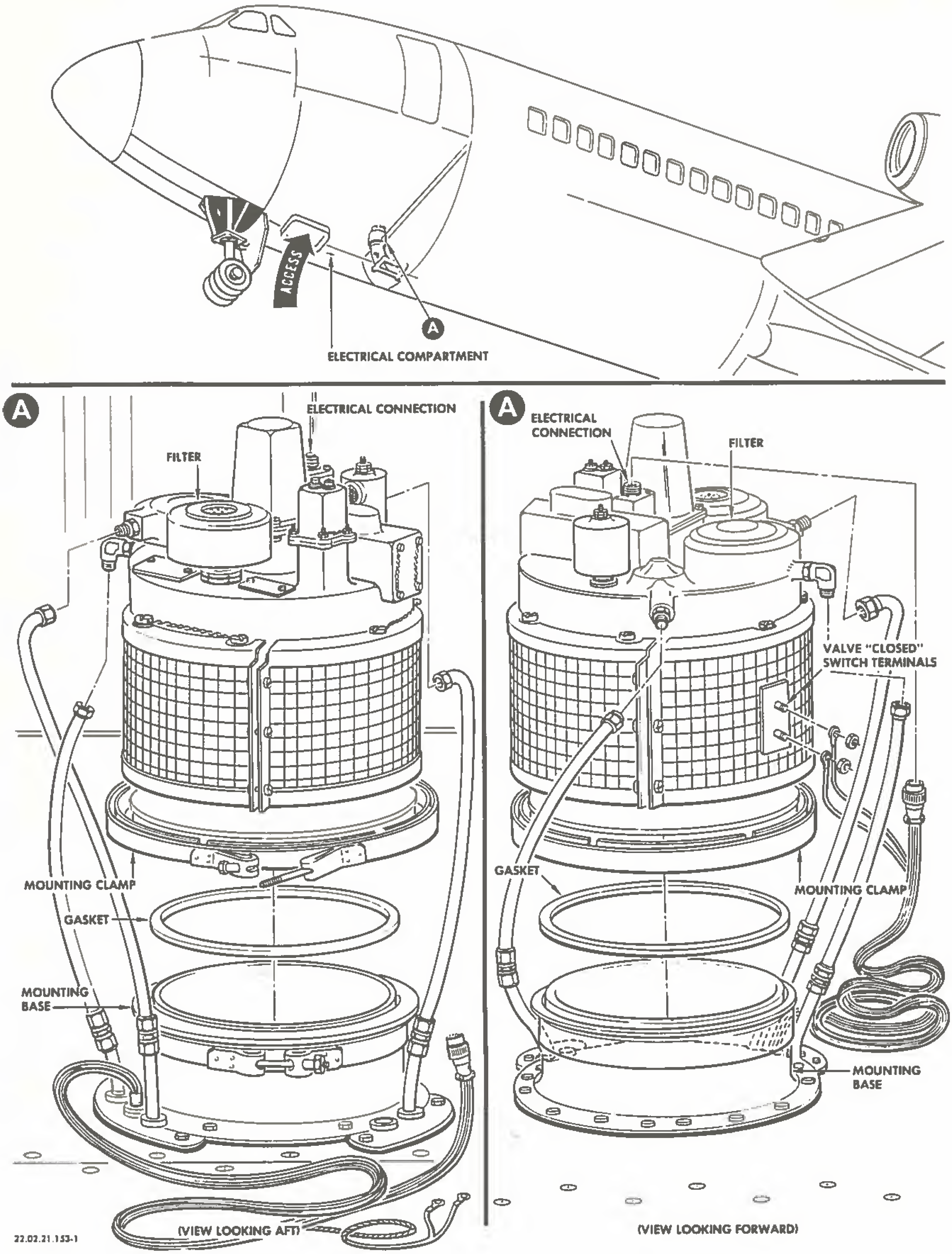
      (1) Position valve on its base with Modification Record Tag forward along centerline of airplane. Ascertain that gasket is placed between valve and mounting base.

      CAUTION: WHEN INSTALLING FORWARD OUTFLOW VALVE MAKE SURE THAT VALVE HAS EXTERNAL PROTECTIVE SCREEN.

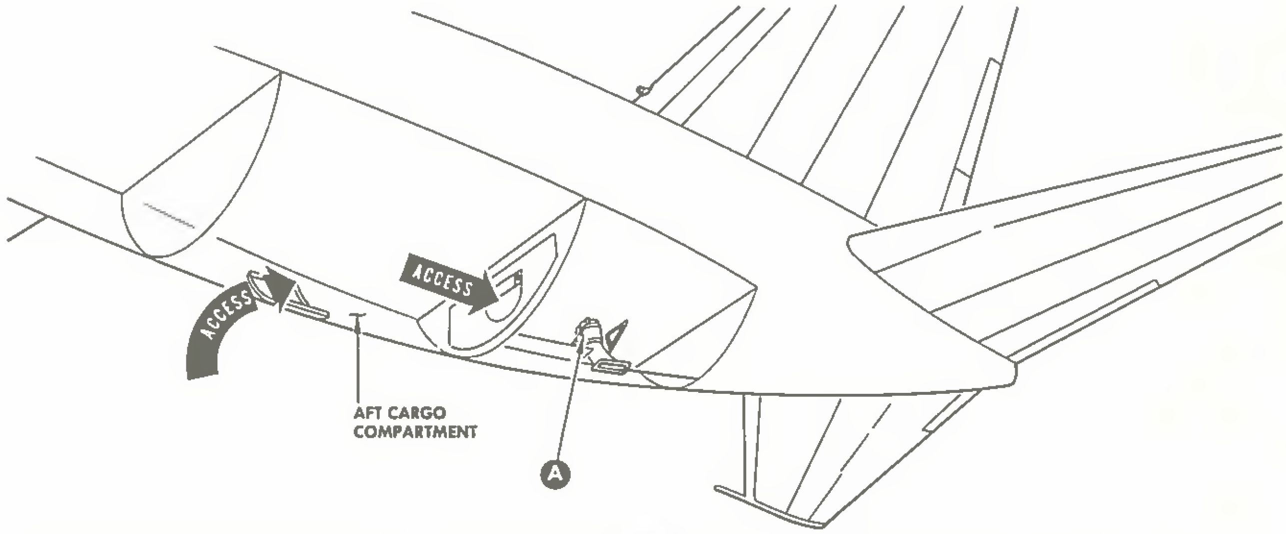
      (2) Position Marman clamp around base of valve; tighten clamp.

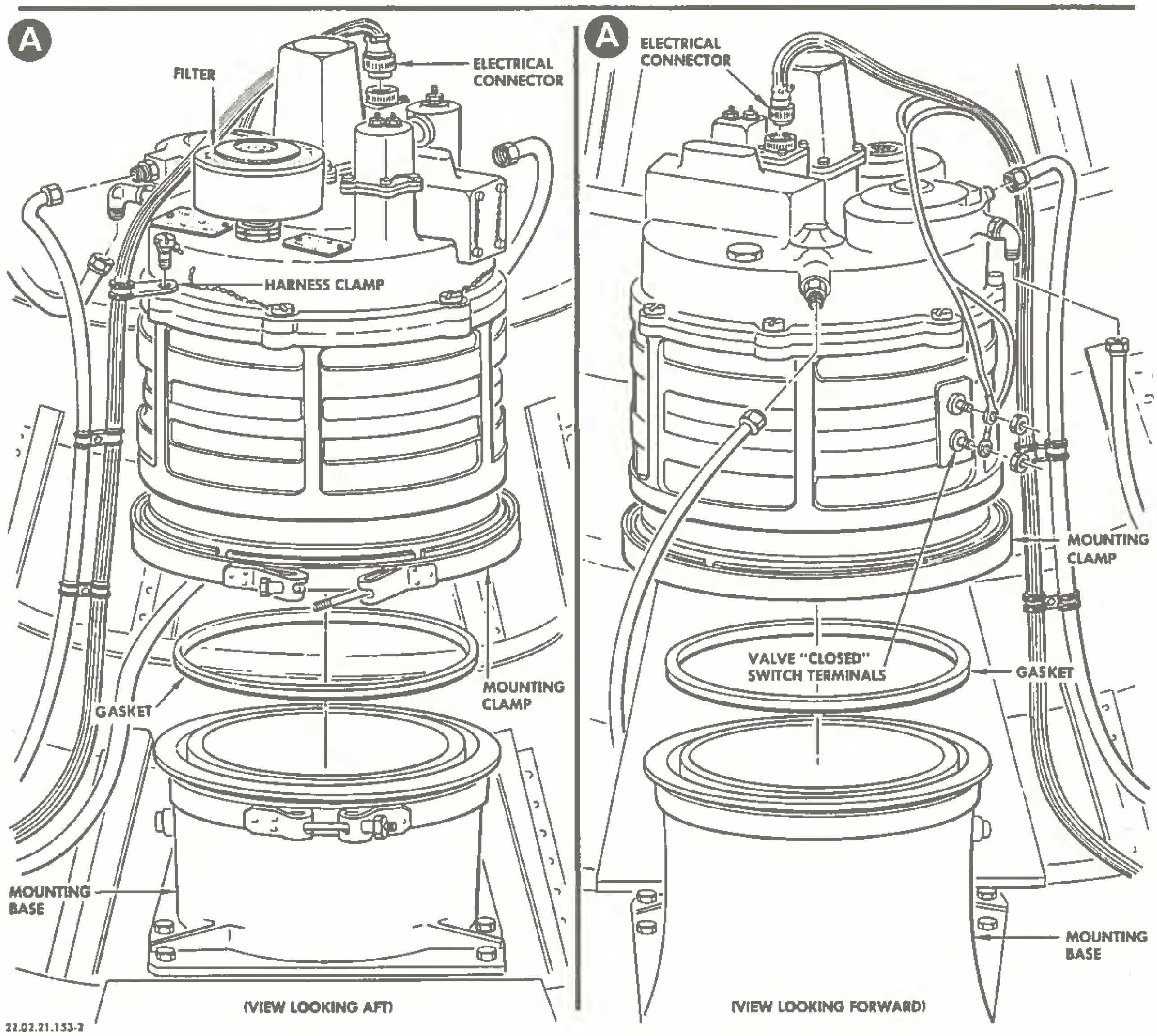
      (3) Connect electrical connector to receptacle on top of valve.

      (4) Connect two wires to terminal strip on side of outflow valve.



Removal of Forward Pressure Regulator and
Outflow Valve
Figure 201 (Sheet 1 of 2)





Removal of Aft Pressure Regulator and Outflow Valve
Figure 201 (Sheet 2 of 2)

(5) Install clips and screws to secure wiring harness to outflow valve.

(6) Position and connect pneumatic tubing. (Tighten each piece of tubing on both ends.)

NOTE: It should not be necessary to bend any of the tubing. If connections do not line up, it is permissible to rotate the valve a few degrees on its base.

(7) Remove warning tags and close FWD and AFT CABIN PRESS REG circuit breakers.

(8) Perform Adjustment/Test procedure (refer to 21-2-0, PRESSURIZATION CONTROLS AND INDICATION).

2. Removal/Installation Pressure Regulator and Outflow Valve Cabin Air Filter (see Figure 201)

A. Equipment Required - None.

B. Remove Pressure Regulator and Outflow Valve Cabin Air Filter.

(1) Open FWD or AFT CABIN PRESS REG circuit breakers as required. Place warning tag on open circuit breaker.

(2) Loosen lower jam nut at base of filter housing.

(3) Unscrew filter housing from top of outflow valve. (Cover port in outflow valve to prevent entry of foreign material.)

(4) Replace filter element and clean filter housing and orifice (refer to Chapter 12, SERVICING).

C. Install Pressure Regulator and Outflow Valve Cabin Air Filter.

(1) Screw filter housing into port on top of outflow valve. Tighten jam nut at base of filter housing.

(2) Close FWD or AFT CABIN PRESS REG circuit breaker and remove warning tag.

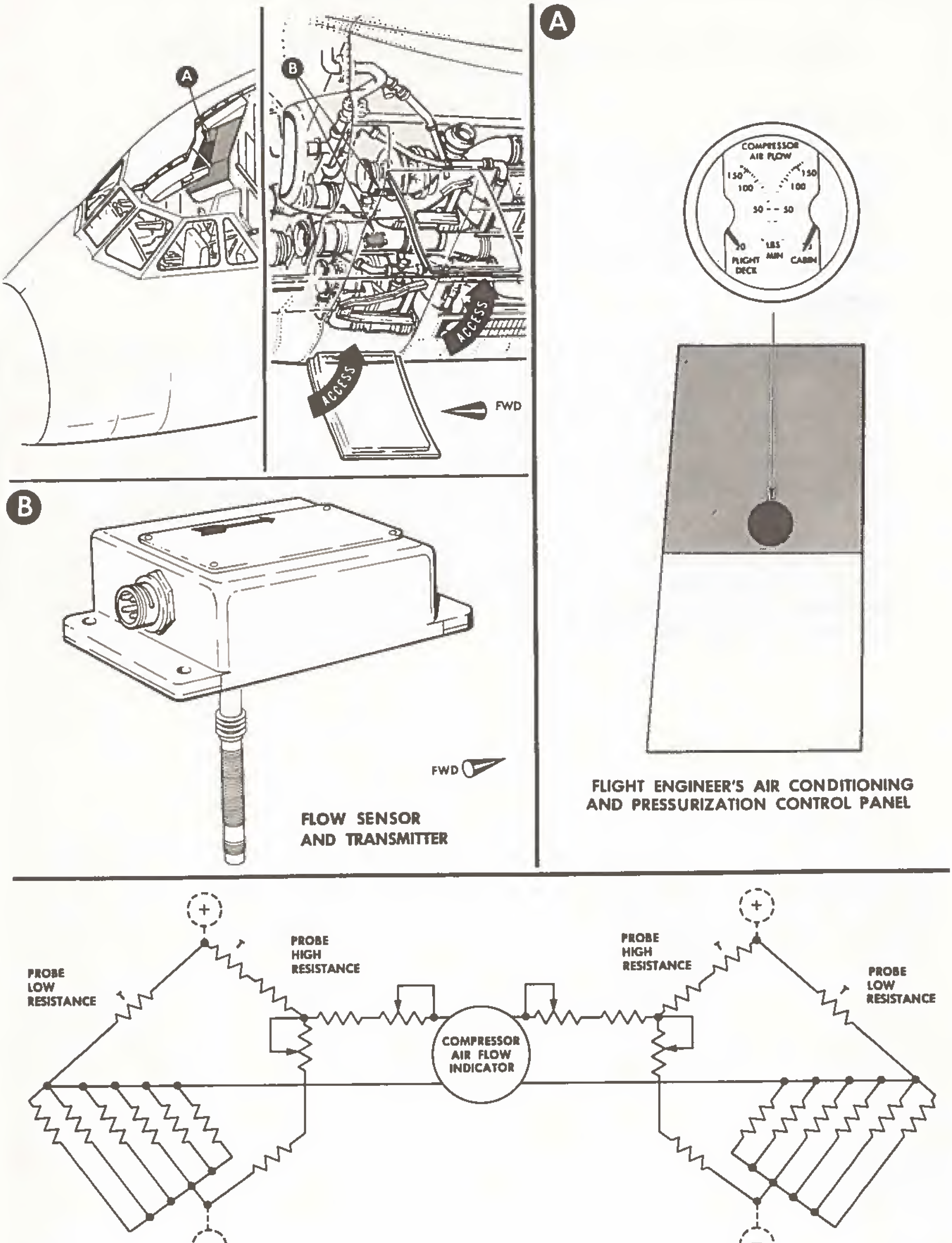
AIRFLOW INDICATOR AND FLOW SENSOR AND TRANSMITTER - DESCRIPTION AND OPERATION

1. Description

The airflow indicator is a dual microammeter, calibrated in units of airflow (pounds per minute). The flow sensor and transmitter, shown on Figure 1, consists of a probe extending from the transmitter into the conditioned air supply duct. The probe contains platinum sensing elements connected to a dc resistance bridge in the transmitter.

2. Operation

The sensing elements on the probe form two legs of a bridge circuit with 28-volt dc power to each element. The longer probe element has a blocking resistor in series with the element so current flow across it will not raise the temperature of the element by any appreciable amount. The smaller probe element is heated by the 28-volt dc power. As air flows across the smaller element it lowers the temperature of the element and consequently changes the resistance, unbalancing one leg of the bridge circuit. The effects of airflow across the longer element are insignificant in the effect on its resistance. Thus, the longer element establishes a constant in relationship to airflow temperature changes. This constant is compared against the resistance of the shorter element in the bridge circuit. The resultant bridge imbalance at the microammeter supplies a reading of relative air volume past the probes.



Airflow Indicator and Flow Sensor and Transmitter
Figure 1

AIRFLOW INDICATOR AND FLOW SENSOR AND TRANSMITTER - MAINTENANCE PRACTICES

1. Removal/Installation Airflow Indicator and Flow Sensor and Transmitter

A. Remove Airflow Indicator.

(1) Open AIR FLOW IND circuit breaker.

(2) Open flight engineer's control panel for access to rear of indicator.

(3) Disconnect electrical connector from airflow indicator. (Tag for installation.)

(4) Remove four screws securing indicator to flight engineer's control panel.

(5) Remove indicator from instrument panel.

B. Install Airflow Indicator.

(1) Connect electrical connector to receptacle on airflow indicator.

(2) Position airflow indicator in instrument panel.

(3) Install four screws to secure indicator to panel.

(4) Close flight engineer's control panel.

(5) Close AIR FLOW IND circuit breaker.

(6) Operate recirculation fan to check airflow indicator (refer to 21-0, Maintenance Practices).

C. Remove Flow Sensor and Transmitter.

NOTE: Remove turbocompressor to facilitate access (refer to 21-1-0, Maintenance Practices).

(1) Open AIR FLOW IND circuit breaker.

(2) Disconnect electrical connector from flow sensor and transmitter. (Tag for installation.)

(3) Remove four screws securing flow sensor and transmitter to ducting.

(4) Remove flow sensor and transmitter.

CAUTION: COVER PROBES WITH PROTECTIVE CAPS.

D. Install Flow Sensor and Transmitter.

(1) With gasket in place, position flow sensor and transmitter with probe extending into duct (directional flow arrow on cover shall point forward).

(2) Install four retaining screws (mounting screw holes in base plate are offset to prevent improper installation).

(3) Connect electrical connector to receptacle or transmitter.

(4) Close AIR FLOW IND circuit breaker.

(5) Operate recirculation fan to check airflow indicator (refer to 21-0, Maintenance Practices).

2. Adjustment/Test Airflow Indicator

A. Equipment Required.

Standard 28-volt dc output test unit containing current regulation and metering provisions from 0-100 microamperes.

B. Preparation.

(1) Remove airflow indicator (refer to Removal/Installation).

(2) Check airflow indicator pointers for zero position. Pointers shall indicate 20-pm (pounds per minute) air weight flow with no input signal applied to indicator.

(3) Adjust indicator pointers to obtain the 20-pm reading as above. An adjustment screw is located at the pivot point of each pointer on the dial face.

NOTE: Adjustment must be made with the indicator level in its normal mounting position.

C. Perform Airflow Indicator Calibration Test.

(1) Connect indicator pins B and D to the negative 28-volt dc output terminal of the test unit.

NOTE: In steps (2) and (3) following do not connect indicator pins A and C to test unit at the same time. Test cabin side of indicator first then test the flight deck side.

(2) Connect indicator pin A to positive 28-volt dc terminal of test unit to check cabin side of indicator.

(3) Adjust test unit to apply a microampere input to the indicator to obtain a simulated airflow indication as given in Table I following. The microampere reading at each airflow indication must fall within the limits given.

TABLE I

AIRFLOW (PM) CABIN/FLIGHT DECK	INPUT (MICROAMPERES)
20	0 (+10, -0)
30	25 (±8)
40	41 (±5)
60	61 (±3)
100	82 (±1)

(4) Repeat steps (2) and (3) preceding substituting pin C for pin A to check flight deck side of indicator.

(5) Replace indicator with new unit if requirements stated in preceding Table cannot be met.

3. Inspection/Check

A. Airflow Indicator.

(1) Check dial face for damage from moisture or dust.

(2) Check for broken dial glass.

(3) Check security of electrical connector and for worn insulation.

(4) Check that indicator retaining screws are secure.

B. Flow Sensor and Transmitter.

(1) Check probe for damage to sensing elements.

(2) Check for damaged threads or pins on electrical receptacle.

(3) Check gasket seal.

4. Cleaning/Painting

A. Clean Airflow Indicator.

(1) Wipe indicator with a cloth moistened with solvent, Specification AMS 3160A.

NOTE: Do not immerse indicator in solvent.

B. Paint Airflow Indicator.

(1) Cover dial glass, name plate, and receptacle with masking tape.

(2) Remove corrosion with fine crocus cloth.

(3) Touch up or repaint with glyceryl phthalate enamel, Specification AMS 3120B using a small brush or spray.

(4) Allow to dry four hours before installation.

C. Clean Flow Sensor and Transmitter.

(1) Clean exterior surfaces of sensor/transmitter housing with a clean dry cloth.

(2) Clean sensing probe by immersing it for five minutes in an ultrasonic cleaning bath filled with alcohol.

NOTE: If ultrasonic cleaning equipment is not available, clean probe by immersing and agitating it in alcohol bath.

CAUTION: DO NOT IMMERSE SENSOR/TRANSMITTER HOUSING IN ALCOHOL, OR CLEAN PROBE WITH AIR PRESSURE, HEAT, OR SOLVENTS OTHER THAN ALCOHOL.

(3) Remove corrosion from sensor/transmitter housing with fine crocus cloth.

D. Paint Flow Sensor and Transmitter.

(1) Touch up damaged painted surfaces with heat resistant black enamel, Specification AMS 3120B.

AIR CONDITIONING SUBSYSTEM - DESCRIPTION AND OPERATION

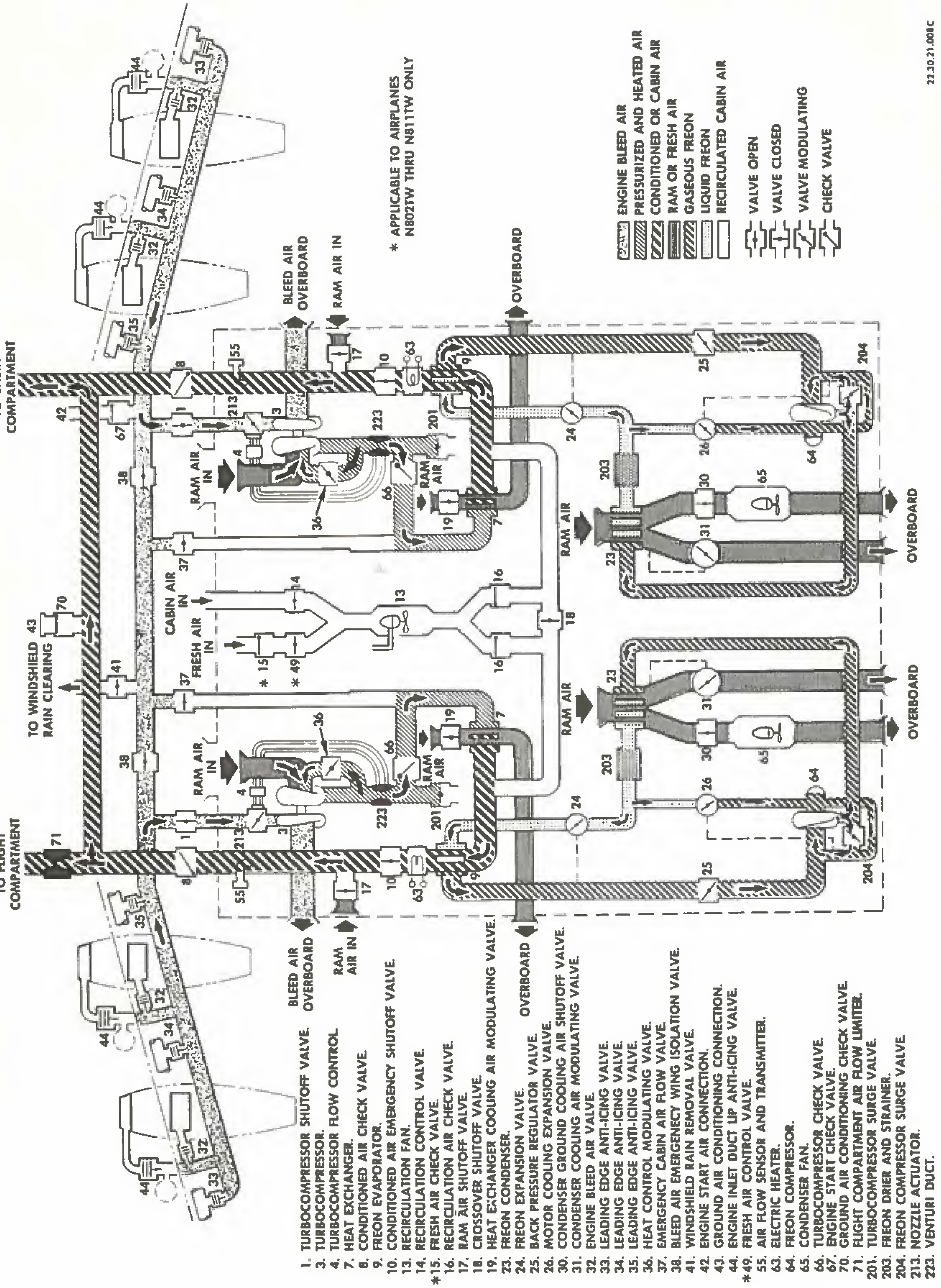
1. General

The air conditioning subsystem consists of two independent parallel air conditioning units and is shown schematically on Figure 1. The parallel air conditioning units are connected by crossover ducting and a cabin air recirculation subsystem. Only one of the units will be discussed as both units are identical except for minor connections which will be noted.

The pressurized air as it leaves the turbocompressor must be heated or cooled as required to provide properly conditioned air for maximum passenger and crew comfort. These demands of heated or cooled air are governed by the temperature control subsystem. Heating of the pressurized air (described in detail in 21-1-0, PRESSURIZATION SUBSYSTEM) is accomplished automatically when the ram air is compressed. The pressurized air can also be heated to a higher temperature by recirculating the compressed air through the compressor. Cooling the air is accomplished, when the airplane is in flight, by the use of an air-to-air heat exchanger backed up by a Freon refrigeration subsystem. The compressed air is ducted from the turbocompressor to an air-to-air heat exchanger for the first stage of cooling. The air after passing through the first stage of cooling is then ducted to the second stage of cooling which utilizes a Freon refrigeration subsystem. Second stage cooling is used only if the first stage is incapable of cooling the air sufficiently to meet the demands of the temperature control subsystem. When the airplane is on the ground no ram air is available for cooling at the air-to-air heat exchanger so it is incapable of meeting any cooling demands. When the air-to-air heat exchanger is incapable of sufficient cooling the Freon refrigeration subsystem is activated and provides cooling of the pressurized air. The heated and/or cooled pressurized air is then ducted to the air distribution subsystem for distribution to the cabin and flight compartments. For a more detailed description and operation of the distribution subsystem, refer to 21-8-0, AIR DISTRIBUTION SUBSYSTEM.

2. Primary Cooling

Pressurized and heated air is ducted from the turbocompressor to the air-to-air heat exchanger. As the air flows to the heat exchanger, it passes through a venturi duct and a check valve. The check valve prevents reverse air flow through the turbocompressor in the event the turbocompressor is not operating and air conditioning and pressurization is being provided by the other turbocompressor or the emergency pressurization subsystem. The air-to-air heat exchanger contains an exchanger core of the plate and fin design. The core provides for one straight through pass for cooling ram air and two passes in a cross-counter flow arrangement for pressurized air. The ram air cools the exterior surface of the core to extract heat from the pressurized air flowing through the inside of the core. The amount of cooling of the pressurized air is regulated by the heat exchanger cooling air modulating valve. The amount of cooling ram air allowed to pass through the heat exchanger by the modulating valve is controlled by the temperature control subsystem. The conditioned air as it leaves the air-to-air heat exchanger is ducted to the Freon evaporator where it will receive



Air Conditioning Schematic
Figure 1

further cooling, when necessary, and dehumidification if cooling is called for and then distributed to the passenger and crew compartments.

3. Freon Refrigeration Subsystem

The secondary cooling stage utilizes a Freon refrigeration subsystem. This is a closed vapor-cycle refrigeration system, utilizing Freon 114 as the coolant, and consisting of a Freon compressor, a condenser, an evaporator, interconnecting tubing, and control devices.

4. Air Conditioning Operation

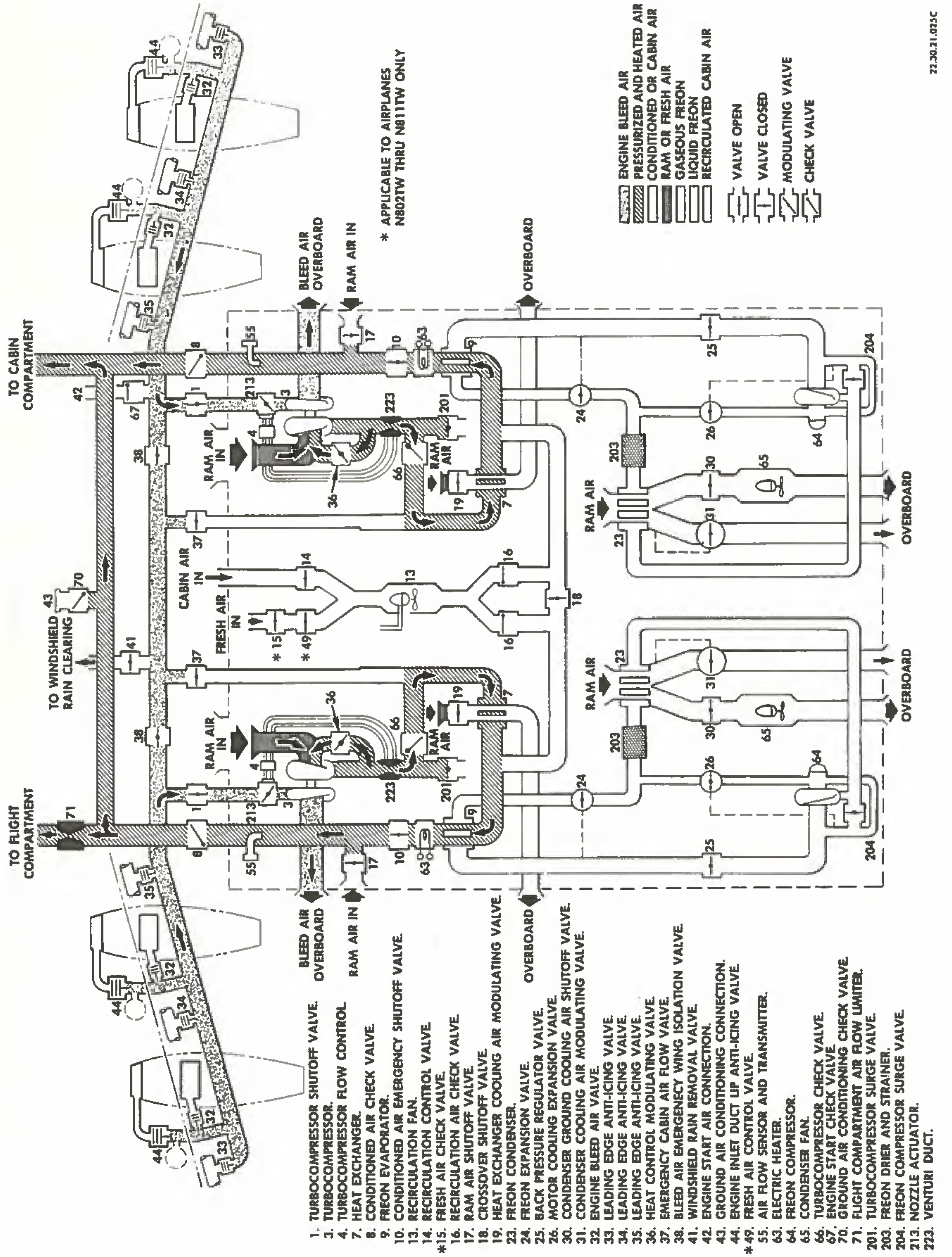
The air conditioning subsystem provides for control of three environmental factors in the airplane; cabin and flight compartment temperatures, replenishing of cabin and flight compartment air, and removal of moisture from the refrigerated air. The air conditioning subsystem must be capable of cooling the compressed air, heating the recirculating cabin air, removing moisture and controlling subsystem operation. Conditioned air heating is accomplished by two different methods; (1) Recirculating pressurized air through the turbocompressor (covered under pressurization subsystem) and (2) electric heating. Air cooling is accomplished by two cooling subsystems; (1) an air-to-air heat exchanger and (2) a Freon refrigeration cooling subsystem. Recirculation of cabin air is accomplished by using an electric driven fan, ducting, and associated valves. Moisture removal is accomplished as a part of the Freon refrigeration subsystem operation. Control of system operation is accomplished by the temperature control subsystem and is covered in 21-4-0, AIR CONDITIONING CONTROL AND INDICATION.

As illustrated in Figure 1, ram air is compressed and heated in the turbocompressor. It is then cooled, if necessary, while flowing through the air-to-air heat exchanger and the Freon evaporator. It is then distributed to the flight and cabin compartments. There are seven normal modes of heating or cooling the flight and cabin compartments while the airplane is in flight or on the ground. These seven modes are described in the following paragraphs.

A. Inflight Heating.

During flight, the recirculation control valve, and/or the fresh air control valve and the electric heater are not subject to control by the temperature control system, thus, these valves are closed and the electric heater is off.

As shown in Figure 2, the turbocompressor shutoff valve is open allowing engine bleed air to operate the turbocompressor. Ram air from the plenum chamber, enters the compressor side of the turbocompressor where it is compressed and heated. If one pass through the compressor does not heat the air enough as called for by the temperature control system, a portion of the air is recirculated through the compressor by the heat control modulating valve.



Air Conditioning Schematic - Inflight Heating
Figure 2

The heated and compressed air then flows through the turbocompressor venturi duct, through the turbocompressor check valve and into the heat exchanger.

The compressed and heated air flows through the heat exchanger without any cooling. When the heat exchanger cooling air modulating valve is closed ram air cannot flow through the heat exchanger for cooling purposes. The conditioned air flows from the heat exchanger and into the Freon evaporator. As the temperature control system is calling for maximum heat, the Freon refrigeration subsystem is inoperative. The conditioned air flows through the Freon evaporator without any cooling and into the electric heaters. The conditioned air flows through the electric heaters with no added heating, because the heaters are inoperative in flight. The conditioned air flows from the electric heaters and passes through the open conditioned air emergency shutoff valve. The air then flows through the conditioned air check valves and is distributed by the air distribution subsystem to the cabin and flight compartments.

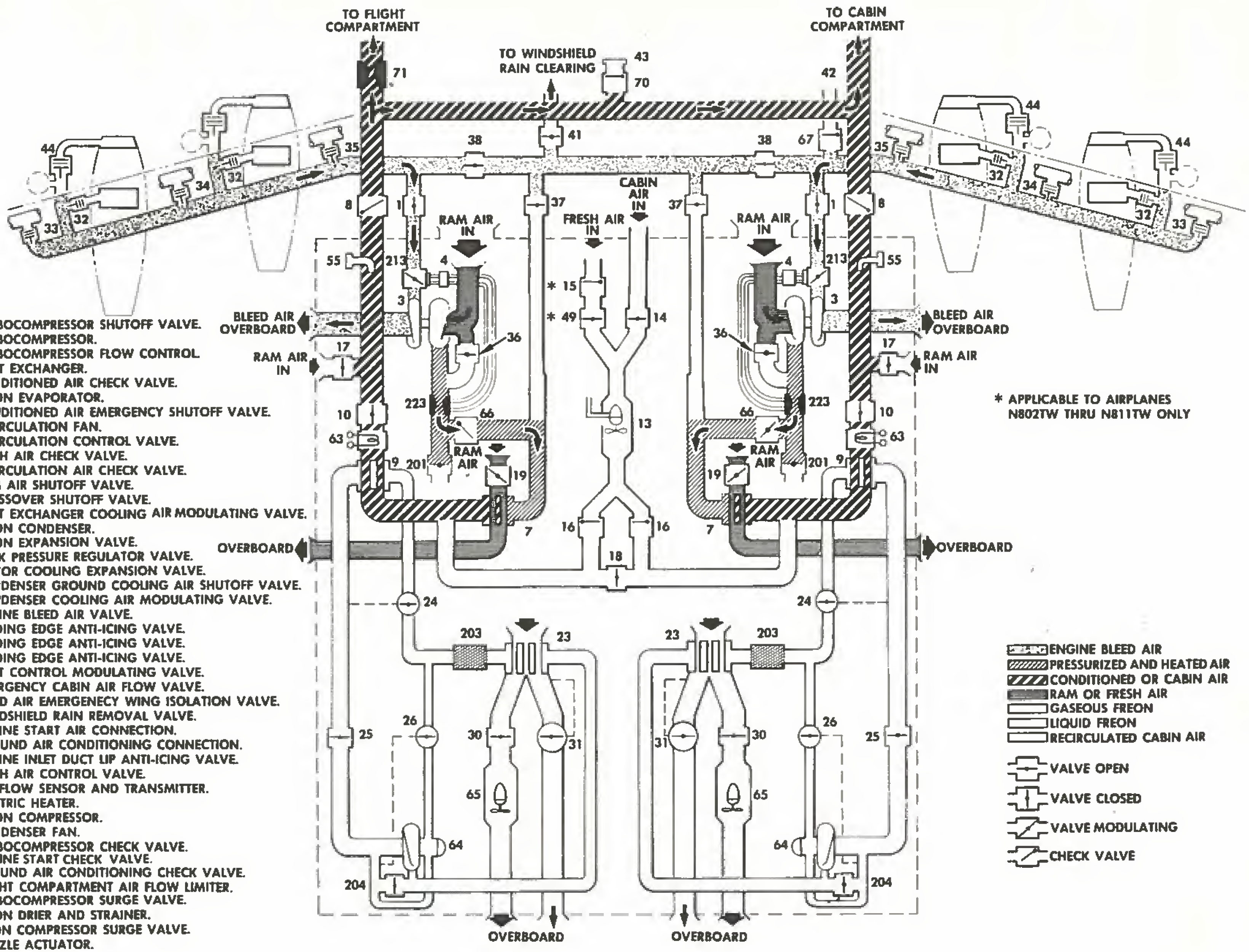
B. Inflight Intermediate.

During the inflight intermediate range, the temperature control system is not calling for additional heating. As shown in Figure 3, the heat control modulating valve is closed, indicating that one pass through the compressor is heating the air sufficiently. The compressed air flows through the venturi duct and the turbocompressor check valve to the air-to-air heat exchanger.

The heat exchanger cooling air modulating valve is in the modulating position indicating that the temperature control system is calling for slightly cooler air than is coming from the turbocompressor. The heat exchanger cooling air modulating valve allows ram air to flow through the air-to-air heat exchanger and is then dumped overboard. The ram air cools the heated air to obtain the air temperature called for by the temperature control system. The compressed and conditioned air leaves the air-to-air heat exchanger and flows through the Freon evaporator. The compressed and conditioned air receives no cooling in the Freon evaporator because sufficient cooling is being accomplished in the air-to-air heat exchanger so the Freon compressor is shut down. The compressed air flows through the electric heater, which is inoperative during flight, then through the open conditioned air emergency shutoff valves and conditioned air check valves. The conditioned air is then routed by the air distribution subsystem to the cabin and flight compartments.

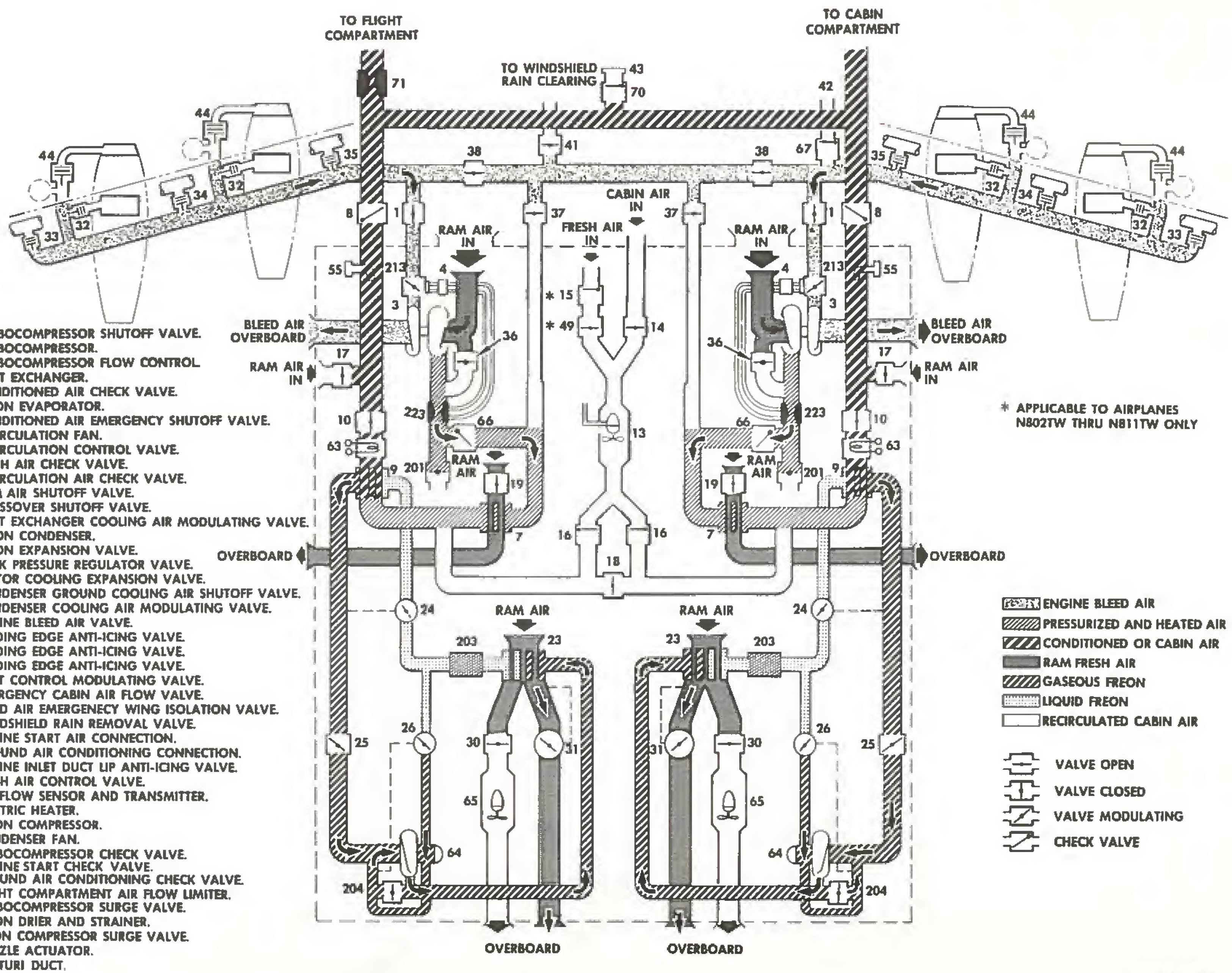
C. Inflight Cooling.

When the temperature control system is calling for cooling, the heat control modulating valve is closed. Ram air is compressed in the turbocompressor and somewhat heated due to compression. The compressed air flows through the venturi duct and the turbocompressor check valve to the air-to-air or primary heat exchanger. As shown in Figure 4, the heat exchanger cooling air modulating valve is open, in this case, full-



1. TURBOCOMPRESSOR SHUTOFF VALVE.
3. TURBOCOMPRESSOR.
4. TURBOCOMPRESSOR FLOW CONTROL.
7. HEAT EXCHANGER.
8. CONDITIONED AIR CHECK VALVE.
9. FREON EVAPORATOR.
10. CONDITIONED AIR EMERGENCY SHUTOFF VALVE.
13. RECIRCULATION FAN.
14. RECIRCULATION CONTROL VALVE.
*15. FRESH AIR CHECK VALVE.
16. RECIRCULATION AIR CHECK VALVE.
17. RAM AIR SHUTOFF VALVE.
18. CROSSOVER SHUTOFF VALVE.
19. HEAT EXCHANGER COOLING AIR MODULATING VALVE.
23. FREON CONDENSER.
24. FREON EXPANSION VALVE.
25. BACK PRESSURE REGULATOR VALVE.
26. MOTOR COOLING EXPANSION VALVE.
30. CONDENSER GROUND COOLING AIR SHUTOFF VALVE.
31. CONDENSER COOLING AIR MODULATING VALVE.
32. ENGINE BLEED AIR VALVE.
33. LEADING EDGE ANTI-ICING VALVE.
34. LEADING EDGE ANTI-ICING VALVE.
35. LEADING EDGE ANTI-ICING VALVE.
36. HEAT CONTROL MODULATING VALVE.
37. EMERGENCY CABIN AIR FLOW VALVE.
38. BLEED AIR EMERGENECY WING ISOLATION VALVE.
41. WINDSHIELD RAIN REMOVAL VALVE.
42. ENGINE START AIR CONNECTION.
43. GROUND AIR CONDITIONING CONNECTION.
44. ENGINE INLET DUCT LIP ANTI-ICING VALVE.
*49. FRESH AIR CONTROL VALVE.
55. AIR FLOW SENSOR AND TRANSMITTER.
63. ELECTRIC HEATER.
64. FREON COMPRESSOR.
65. CONDENSER FAN.
66. TURBOCOMPRESSOR CHECK VALVE.
67. ENGINE START CHECK VALVE.
70. GROUND AIR CONDITIONING CHECK VALVE.
71. FLIGHT COMPARTMENT AIR FLOW LIMITER.
201. TURBOCOMPRESSOR SURGE VALVE.
203. FREON DRIER AND STRAINER.
204. FREON COMPRESSOR SURGE VALVE.
213. NOZZLE ACTUATOR.
223. VENTURI DUCT.

Air Conditioning Schematic - Inflight Intermediate
Figure 3



1. TURBOCOMPRESSOR SHUTOFF VALVE.
3. TURBOCOMPRESSOR.
4. TURBOCOMPRESSOR FLOW CONTROL.
7. HEAT EXCHANGER.
8. CONDITIONED AIR CHECK VALVE.
9. FREON EVAPORATOR.
10. CONDITIONED AIR EMERGENCY SHUTOFF VALVE.
13. RECIRCULATION FAN.
14. RECIRCULATION CONTROL VALVE.
*15. FRESH AIR CHECK VALVE.
16. RECIRCULATION AIR CHECK VALVE.
17. RAM AIR SHUTOFF VALVE.
18. CROSSOVER SHUTOFF VALVE.
19. HEAT EXCHANGER COOLING AIR MODULATING VALVE.
23. FREON CONDENSER.
24. FREON EXPANSION VALVE.
25. BACK PRESSURE REGULATOR VALVE.
26. MOTOR COOLING EXPANSION VALVE.
30. CONDENSER GROUND COOLING AIR SHUTOFF VALVE.
31. CONDENSER COOLING AIR MODULATING VALVE.
32. ENGINE BLEED AIR VALVE.
33. LEADING EDGE ANTI-ICING VALVE.
34. LEADING EDGE ANTI-ICING VALVE.
35. LEADING EDGE ANTI-ICING VALVE.
36. HEAT CONTROL MODULATING VALVE.
37. EMERGENCY CABIN AIR FLOW VALVE.
38. BLEED AIR EMERGENECY WING ISOLATION VALVE.
41. WINDSHIELD RAIN REMOVAL VALVE.
42. ENGINE START AIR CONNECTION.
43. GROUND AIR CONDITIONING CONNECTION.
44. ENGINE INLET DUCT LIP ANTI-ICING VALVE.
*49. FRESH AIR CONTROL VALVE.
55. AIR FLOW SENSOR AND TRANSMITTER.
63. ELECTRIC HEATER.
64. FREON COMPRESSOR.
65. CONDENSER FAN.
66. TURBOCOMPRESSOR CHECK VALVE.
67. ENGINE START CHECK VALVE.
70. GROUND AIR CONDITIONING CHECK VALVE.
71. FLIGHT COMPARTMENT AIR FLOW LIMITER.
201. TURBOCOMPRESSOR SURGE VALVE.
203. FREON DRIER AND STRAINER.
204. FREON COMPRESSOR SURGE VALVE.
213. NOZZLE ACTUATOR.
223. VENTURI DUCT.

Air Conditioning Schematic - Inflight Cooling
Figure 4

open, because the temperature control system is calling for more cooling than the heat exchanger can provide.

The compressed air flows through the air-to-air heat exchanger to the Freon evaporator. Because the air-to-air heat exchanger is operating at capacity and the temperature control system is calling for more cooling, the Freon refrigeration system is turned on, the Freon compressor is operating and the Freon expansion valve, the back pressure regulator valve, and the motor cooling expansion valve are still modulating. When the Freon compressor is operating, Freon gas is passed through the compressor where it is compressed, resulting in an increase of its temperature and pressure.

The compressed Freon gas then flows from the compressor and enters the condenser where the heat is removed by cool ram air blowing across the condenser. As the heat is removed from the Freon gas, it condenses into a liquid. The ram air utilized for cooling is then dumped overboard. The liquid Freon from the condenser enters the evaporator through the Freon expansion valve. The Freon expansion valve controls the amount of liquid Freon entering the evaporator and limits it to only the amount that will evaporate back into a gas before it leaves the evaporator. Heat is absorbed by the Freon during evaporation. This heat is extracted from the air flowing to the cabin or flight compartment. Thus, the temperature of the air is reduced. The Freon gas from the evaporator then flows back through the compressor where the cycle is repeated.

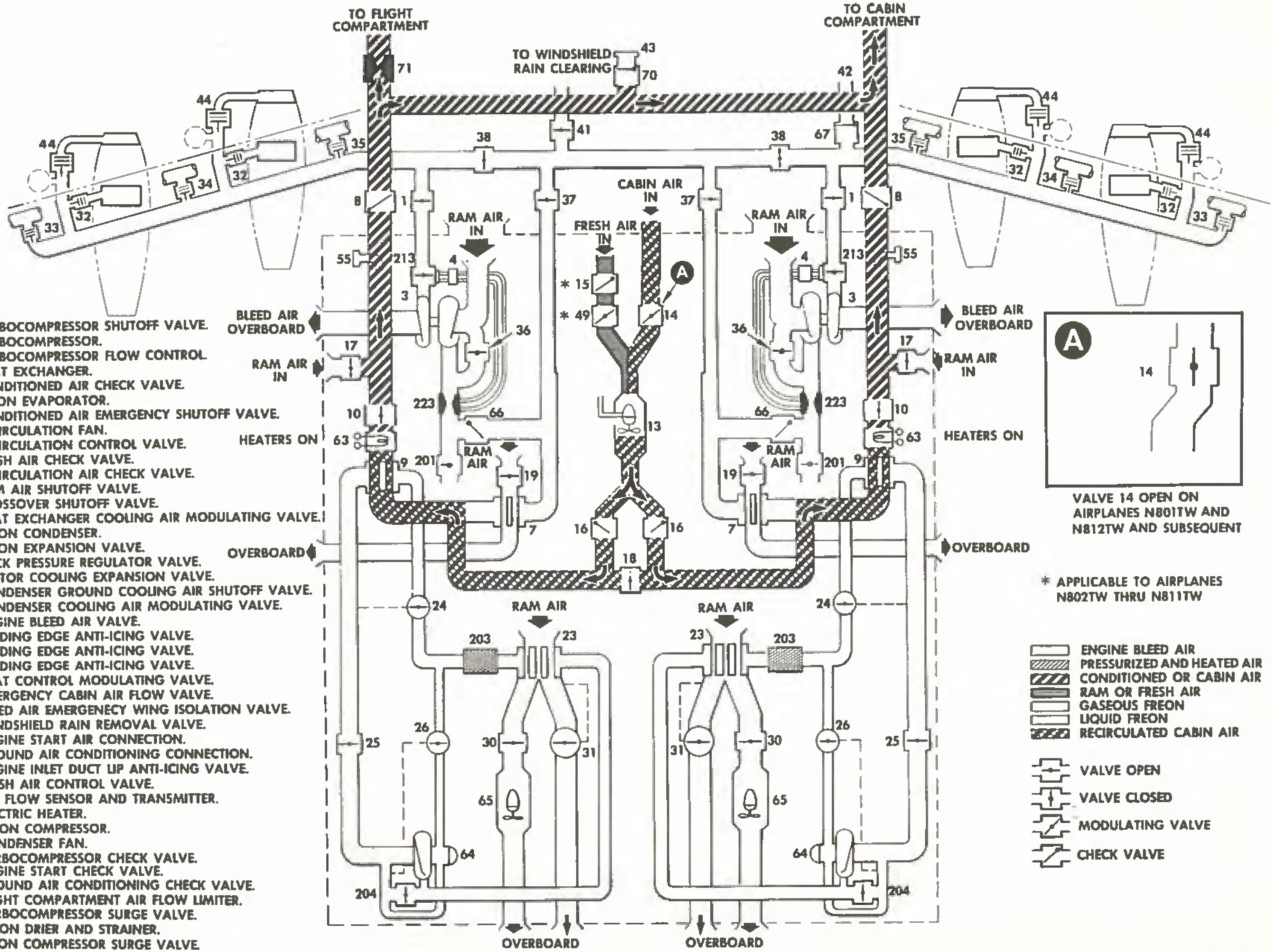
D. Ground Maximum Heating (applicable to airplanes N802TW through N812TW).

When the airplane is on the ground and the turbocompressors are not operating (see Figure 5), cabin air is recirculated by the recirculation fan. Cabin air is picked up through the recirculation control valve while ambient air from the plenum chamber is picked up through the fresh air check valve and the fresh air control valve.

The recirculation control valve and the fresh air control valve are in the modulating position. The recirculation fan is operating and drawing air through the ducting from either the cabin and/or ambient air. The air is then ducted through the recirculation air check valve to the Freon evaporator.

Under heating conditions, the Freon subsystem is shut down and Freon subsystem valves are in closed positions. The conditioned air flows through the Freon evaporator with no cooling and then to the electric heaters. The electric heaters are turned on and will heat the air to the amount called for by the temperature control system. The conditioned air continues on, through the conditioned air emergency shutoff valve and through the conditioned air check valve to the flight compartment and cabin.

NOTE: At the point of maximum heating, only cabin recirculation air is used since the fresh air control valves are closed.



1. TURBOCOMPRESSOR SHUTOFF VALVE.
3. TURBOCOMPRESSOR.
4. TURBOCOMPRESSOR FLOW CONTROL.
7. HEAT EXCHANGER.
8. CONDITIONED AIR CHECK VALVE.
9. FREON EVAPORATOR.
10. CONDITIONED AIR EMERGENCY SHUTOFF VALVE.
13. RECIRCULATION FAN.
14. RECIRCULATION CONTROL VALVE.
*15. FRESH AIR CHECK VALVE.
16. RECIRCULATION AIR CHECK VALVE.
17. RAM AIR SHUTOFF VALVE.
18. CROSSOVER SHUTOFF VALVE.
19. HEAT EXCHANGER COOLING AIR MODULATING VALVE.
23. FREON CONDENSER.
24. FREON EXPANSION VALVE.
25. BACK PRESSURE REGULATOR VALVE.
26. MOTOR COOLING EXPANSION VALVE.
30. CONDENSER GROUND COOLING AIR SHUTOFF VALVE.
31. CONDENSER COOLING AIR MODULATING VALVE.
32. ENGINE BLEED AIR VALVE.
33. LEADING EDGE ANTI-ICING VALVE.
34. LEADING EDGE ANTI-ICING VALVE.
35. LEADING EDGE ANTI-ICING VALVE.
36. HEAT CONTROL MODULATING VALVE.
37. EMERGENCY CABIN AIR FLOW VALVE.
38. BLEED AIR EMERGENECY WING ISOLATION VALVE.
41. WINDSHIELD RAIN REMOVAL VALVE.
42. ENGINE START AIR CONNECTION.
43. GROUND AIR CONDITIONING CONNECTION.
44. ENGINE INLET DUCT LIP ANTI-ICING VALVE.
*49. FRESH AIR CONTROL VALVE.
55. AIR FLOW SENSOR AND TRANSMITTER.
63. ELECTRIC HEATER.
64. FREON COMPRESSOR.
65. CONDENSER FAN.
66. TURBOCOMPRESSOR CHECK VALVE.
67. ENGINE START CHECK VALVE.
70. GROUND AIR CONDITIONING CHECK VALVE.
71. FLIGHT COMPARTMENT AIR FLOW LIMITER.
201. TURBOCOMPRESSOR SURGE VALVE.
203. FREON DRIER AND STRAINER.
204. FREON COMPRESSOR SURGE VALVE.
213. NOZZLE ACTUATOR.
223. VENTURI DUCT.

Air Conditioning Schematic - Ground Maximum Heating
Figure 5

E. Ground Heating (applicable to airplanes N802TW through N811TW).

Ground heating, shown in Figure 6, is the same as Ground Maximum Heating except that fresh air is heated in variable degrees. Each electric heater is actually seven electric heater elements and the number of heater elements turned on is determined by the sequencing device which in turn is operated by the temperature control system. As more heating is called for, the sequencing device will place more heater elements in the on position. As less heating is called for, the sequencing device will call for less heater elements to be turned on. The rest of the system operation is the same as in the previous paragraph.

F. Ground Heating (applicable to airplanes N801TW and N812TW through N830TW).

The ground heating function for these airplanes is identical to Ground Maximum Heating on airplanes N802TW through N830TW when the point of maximum heating is reached. Only cabin recirculated air is available for heating due to the absence of the fresh air control valves.

G. Ground Cooling (applicable to airplanes N802TW through N811TW).

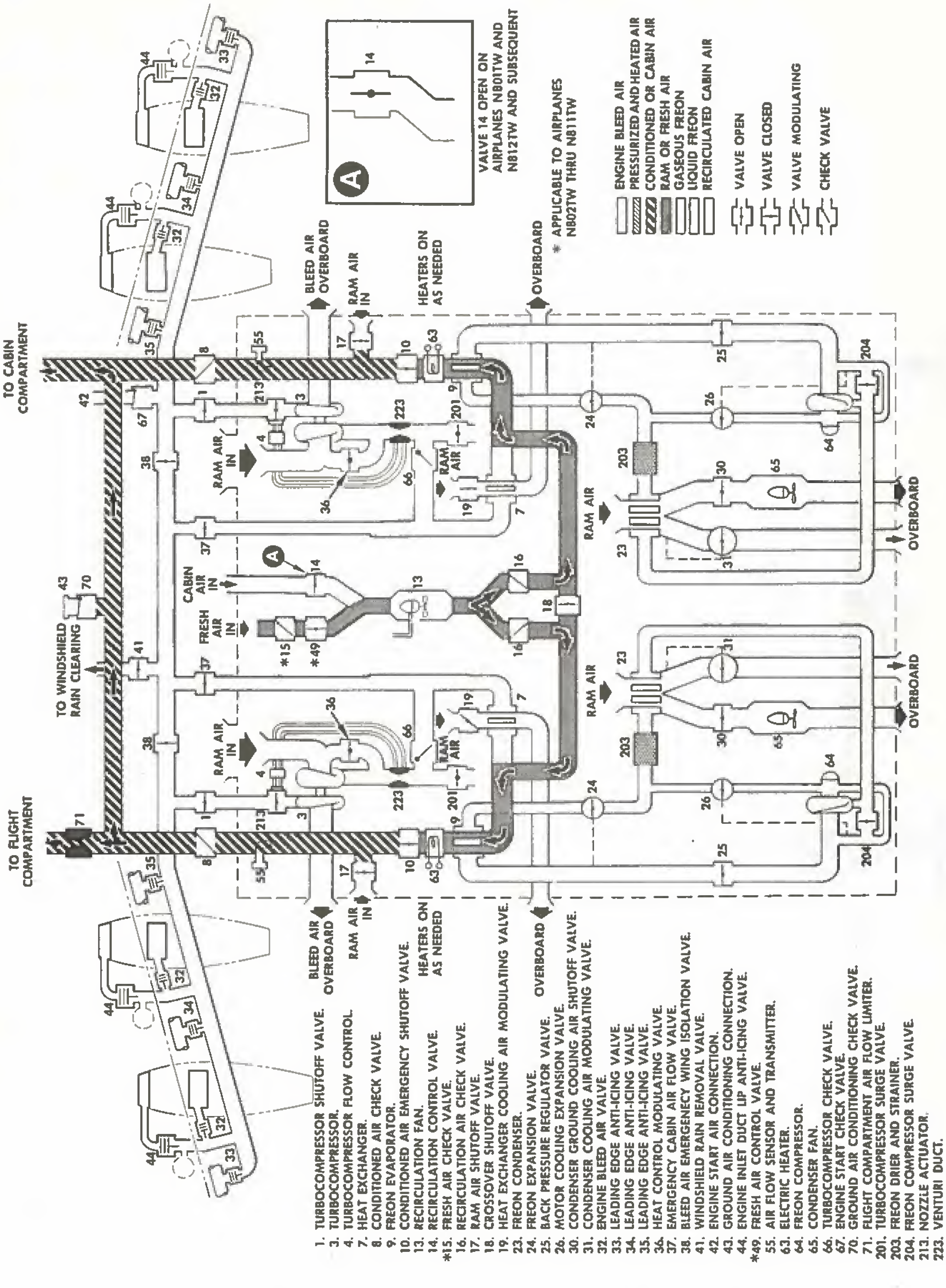
With the airplane on the ground, the engines shut down, and the temperature control system calling for cool air, the system works as follows: As shown in Figure 7, the turbocompressors are inoperative, the recirculation fan is on, the recirculation control valve is closed, and fresh air control valve is open. The ambient air is moved by the recirculation fan from the plenum chamber to the Freon evaporator, where it is cooled to the temperature asked for by the temperature control system and moves on to the electric heaters. As the temperature control system is calling for cooling, the electric heaters are inoperative and the conditioned air moves through the open conditioned air emergency shutoff valve and the conditioned air check valves into the cabin and flight compartments.

H. Ground Cooling (applicable to airplanes N801TW and N812TW through N830TW).

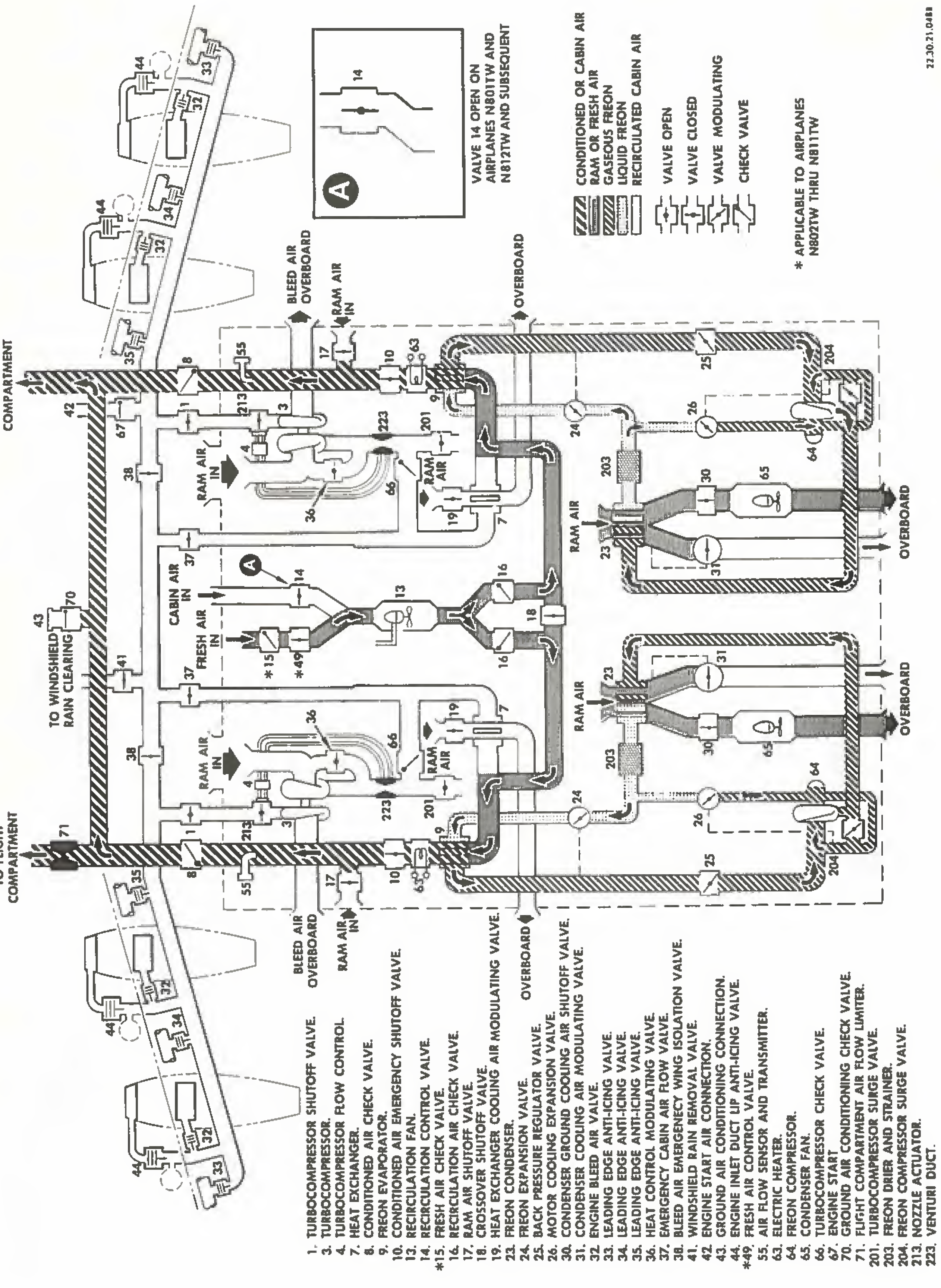
The ground cooling function for these airplanes is identical to Ground Cooling on airplanes N802TW through N811TW except the recirculation control valve is open (no fresh air valve). Thus, only cabin air is available for recirculation through the system. The amount of cooling of the recirculated cabin air is dependent upon the demands of the temperature control system.

I. Ground Maximum Cooling (applicable to airplanes N802TW through N811TW).

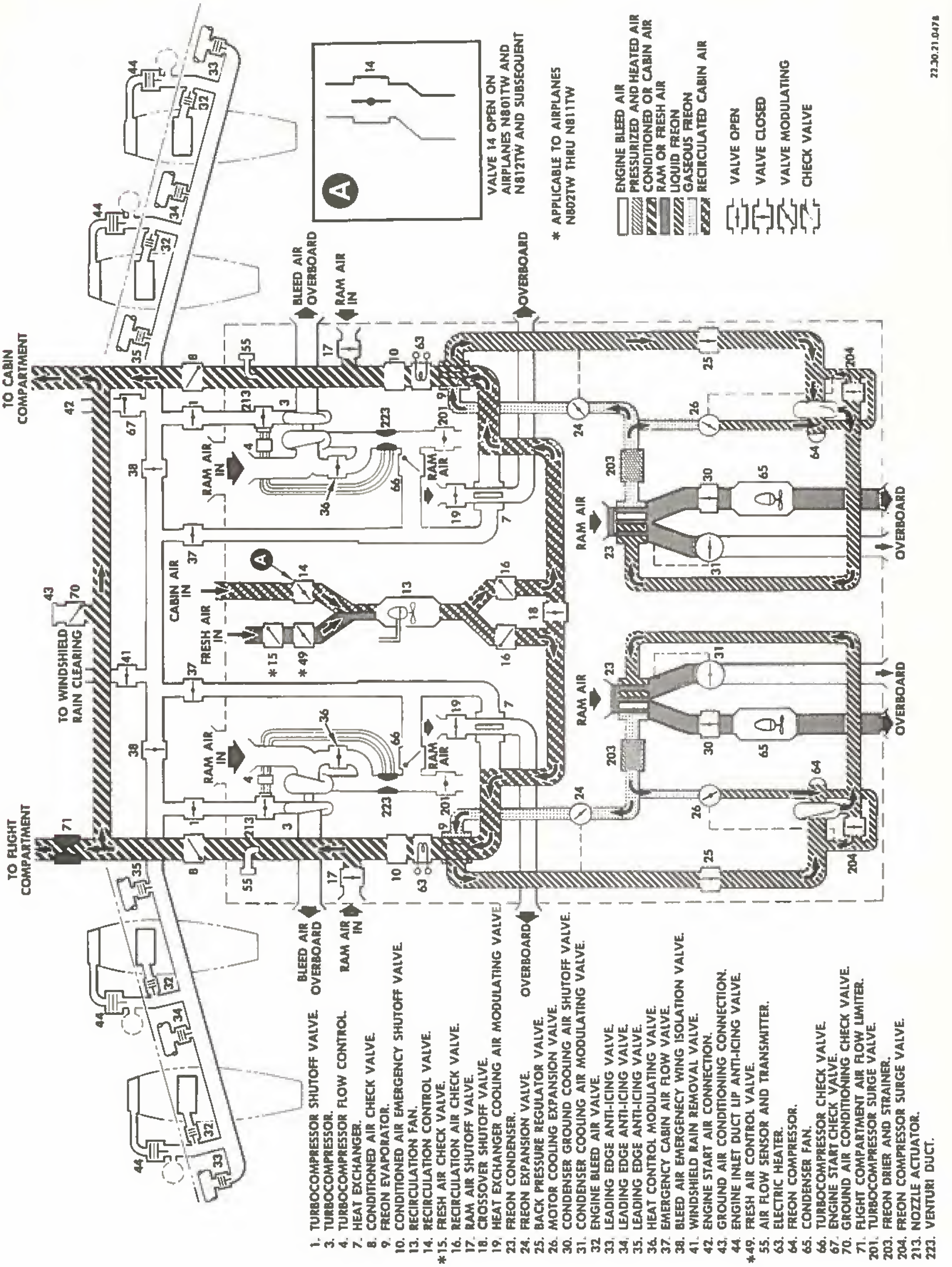
With the airplane on the ground, the engines shut down, and the temperature control system calling for maximum cooling, the system works as follows: As in the paragraph on Ground Cooling and shown in Figure 8, the turbocompressors are inoperative, the recirculation fan is on, and the recirculation control and fresh air control valves are modulating. The cabin and ambient air is moved by the recirculation fan to the



Air Conditioning Schematic - Ground Heating
Figure 6



Air Conditioning Schematic - Ground Cooling
Figure 7



Air Conditioning Schematic - Ground Maximum Cooling
Figure 8

Freon evaporator. The temperature control system is calling for more, or maximum cooling; so consequently, the Freon refrigeration subsystem is operating. Cabin air flows through the Freon evaporator and is cooled to obtain the air temperature called for by the temperature control. The cooled air then flows through the inoperative electric heaters, through the open conditioned air emergency shutoff valves, through the conditioned air check valves and into the cabin and flight compartments.

NOTE: During maximum cooling, only recirculated cabin air is used (fresh air control valve is closed).

AIR CONDITIONING SUBSYSTEM - TROUBLE SHOOTING

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION

1. LOSS OF TEMPERATURE CONTROL IN AUTOMATIC OPERATION. (MANUAL TEMPERATURE CONTROL OK)

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION
A. Malfunctioning temperature control (Cabin or Flight Compartment)	Operate cabin and flight compartment systems one at a time to identify which does not deliver heated or cooled air as scheduled. Swap temperature controls (Location RH wheel well) between cabin and flight compartment systems. If the faulty system then operates properly, replace the malfunctioning temperature control.
B. Malfunctioning temperature selector or thermal resistor.	Replace temperature selector on the flight engineer's panel. If no result, replace the duct pickup thermal resistor. If no result, replace the discharge duct pickup thermal resistor.

2. LOSS OF TEMPERATURE CONTROL IN MANUAL OPERATION (AUTOMATIC OPERATION OK)

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION
A. Malfunctioning switch, wiring or temperature control.	Check operation of the AUTO-OFF-MAN switch, the MAN HOT-MAN COLD switch, the 130 degree limit switch, and the associated wiring to the temperature control. Operate cabin and flight compartment systems one at a time to identify which does not deliver heated or cooled air as scheduled. Swap temperature controls (Location RH wheel well) between cabin and flight compartment systems. If the faulty system then operates properly, replace the malfunctioning temperature control. CAUTION: DO NOT USE AN OHMETER FOR CHECKING WIRES CONNECTED TO THE TEMPERATURE CONTROL.

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION
3. LOSS OF TEMPERATURE CONTROL IN BOTH AUTOMATIC AND MANUAL OPERATION	
A. Malfunctioning temperature control.	Refer to 1A above.
B. Malfunctioning sequencing device.	Operate the air conditioning system and manually schedule full heating. The electric heater shall operate, and the Freon package shall be shut down. Then manually schedule full cooling. The Freon package shall operate, and the electric heater shall be shut down. If above conitions do not exist, replace the sequencing device.
4. INADEQUATE COOLING. (FREON FAIL WARNING LIGHT NOT ILLUMINATED)	
A. Loss of Freon	Check Freon liquid level gage for proper quantity.
B. Malfunctioning Heat Exchanger cool air modulating valve.	Simulate airborne conditions and manually schedule full cooling. The valve shall be fully open. If it is not open, check operation of heat exchanger cool air modulating valve.
5. INADEQUATE HEATING (AIRBORNE OPERATION ONLY)	
A. Malfunction of the heat exchanger cool air modulating valve.	Simulate airborne operation and manually schedule full heating. The heat exchanger cool air modulating valve shall be fully closed. If not closed, check operation of the heat exchanger cool air modulating valve.
B. Malfunction of the heat control modulating valve.	Simulate airborne operation of the turbocompressor and manually schedule full heating. The electric actuator on the heat control modulating valve shall be open. If the actuator indicates the open position, feel at a conditioned air outlet for heated air. If heating is still inadequate, check operation of the pneumatic actuator on the heat control modulating valve, the heat recirculation temperature limiter control, and the connecting tubing.

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION
	If the electric actuator is closed in the above check, shut down the system. Place AUTO-OFF-MAN temperature control switch in the OFF position. Disconnect the electrical connector from the valve actuator and temporarily connect it to a replacement actuator held under the turbocompressor package. Operate system as outlined above. If the replacement actuator moves to the open position, replace the heat control modulating valve.

6. INADEQUATE HEATING (GROUND OPERATION ONLY)

A. Malfunction of electric heater or heater controls.	Operate air conditioning system and recirculation fan. Manually schedule full heating. The electric heater shall deliver heated air. If heating is inadequate, check operation of recirculation fan control relay and ground safety relays. (Both must be energized to operate the heater control relays.) Check circuit breakers and heater control relays located in the Freon package compartment. Check 115 volt ac wiring to the heater terminals.

7. INADEQUATE COOLING OR HEATING ACCOMPANIED BY A WARNING LIGHT

A. Inadequate cooling with the Freon Fail warning light illuminated.	Refer to 21-3-1, FREON REFRIGERATION ASSEMBLY (FREON PACKAGE).
B. Inadequate heating with the Overspeed Trip light illuminated.	Refer to 21-1-0, TURBOCOMPRESSOR.

FREON REFRIGERATION ASSEMBLY (FREON PACKAGE) - DESCRIPTION AND OPERATION

1. Description

The Freon package is a closed vapor cycle refrigeration system consisting of a compressor, condenser, evaporator, interconnecting tubing, and control devices. See Figure 1 for a schematic of the Freon package. The package operates on the principle that evaporation is a cooling process. Freon 114 gas is compressed and condensed into a liquid, and then evaporated to provide cooling of cabin air. Since the cooling also causes moisture to condense in the evaporator, the system provides humidity control by removing moisture from the cabin air.

The Freon refrigeration system is subject to both automatic and manual control by a series of switches and temperature selectors on the flight engineer's control panel. The output of the system may be regulated from full cooling to essentially zero cooling while maintaining stable operation. For convenience this manual will refer to the cabin Freon package. The flight compartment package is identical, and the packages are interchangeable.

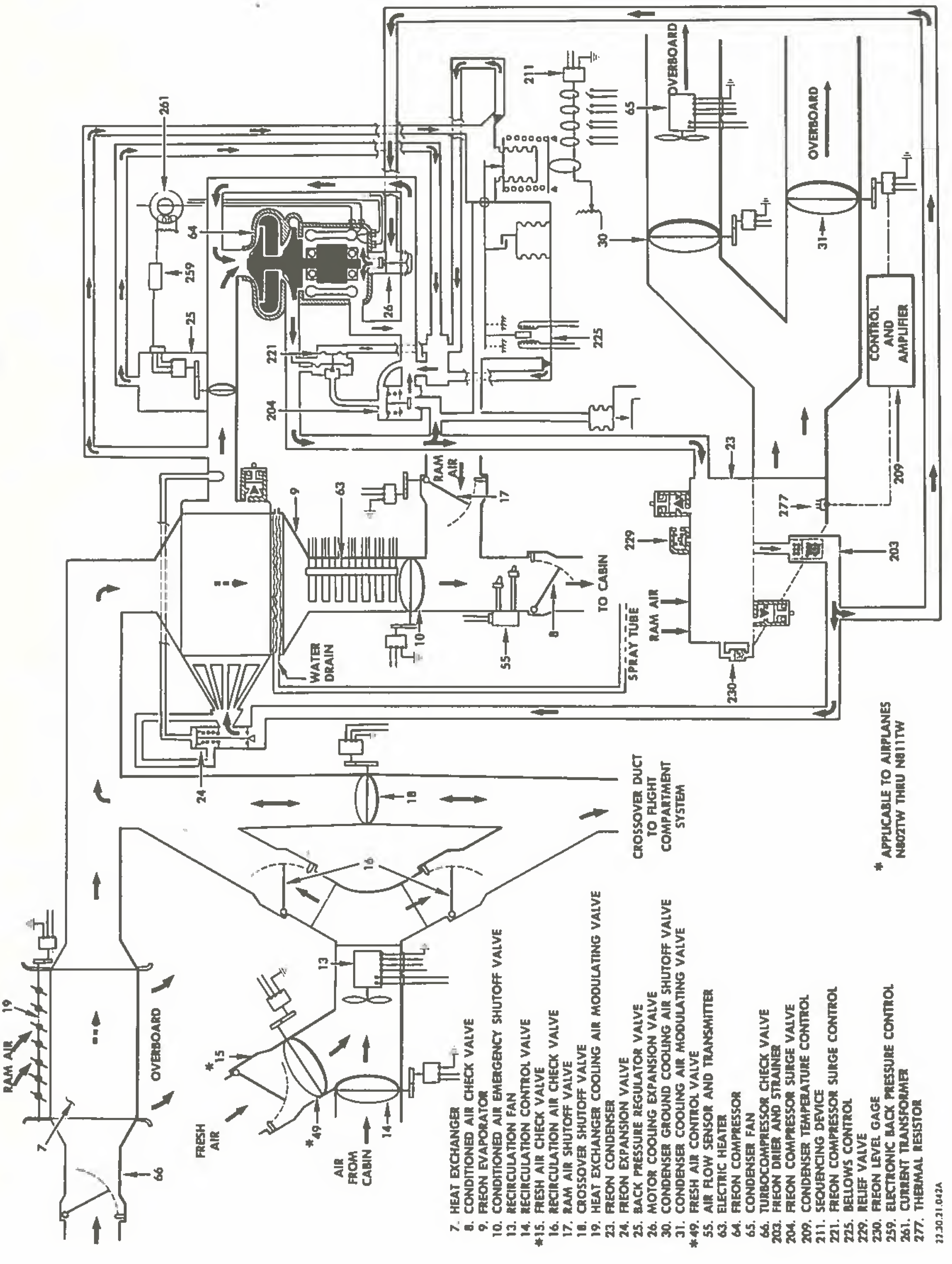
2. Operation

A. Freon Compression.

Freon 114 is drawn into the compressor as a low pressure gas. The Freon gas is compressed and its temperature rises as its pressure increases. The Freon is expelled from the compressor as a high pressure, high temperature gas. The compressed and heated Freon gas enters the Freon condenser where the heat is removed by cool ram air (during flight) or a fan induced air flow (during approach and during ground operations). As the heat is removed, the gas condenses into a liquid. The ram air or fan induced airflow, utilized for cooling the Freon in the condenser, is dumped overboard.

B. Freon Evaporation.

The liquid Freon from the condenser is allowed to enter the evaporator through the Freon expansion valve at a rate which will assure complete vaporization of the liquid Freon before it leaves the evaporator. The expansion valve provides a pressure drop to reduce Freon from a high pressure liquid to a low pressure liquid which can be boiled by low temperature air. Heat is absorbed by the Freon during evaporation. Thus the temperature of the cabin and flight compartment air is lowered by extracting the heat from it before it enters the compartments. The Freon gas leaving the evaporator is returned to the compressor where the cycle is repeated. A back pressure regulator valve is utilized to control the amount of cooling obtained from the vapor cycle system by regulating the Freon flow within the Freon package.



Freon Refrigeration System Functional Diagram
Figure 1

C. Lubrication and Motor Cooling Loops.

An electric motor driven compressor is used to compress the Freon gas. Cooling of the motor and lubrication of its bearing is accomplished by vaporizing the liquid Freon (which contains a small quantity of lubricating oil) over the bearing areas. A thermal switch sensing motor stator coil temperatures protects against excessive operating temperatures.

A hermetically sealed housing encloses the motor and compressor to provide maximum protection against loss of Freon or admission of air into the system.

The motor cooling loop flow path is from the condenser through the motor cooling expansion valve into the section of the compressor housing which encloses the electric motor, through the compression section of the compressor, and back to the condenser.

D. Compressor Surge Control.

A bypass loop prevents Freon compressor surge when limited Freon flow exists in the main cooling loop due to a reduced cooling requirement. The flow path is from the Freon compressor outlet through the compressor surge valve over the expansion valve thermo bellows and back to the inlet of the compressor.

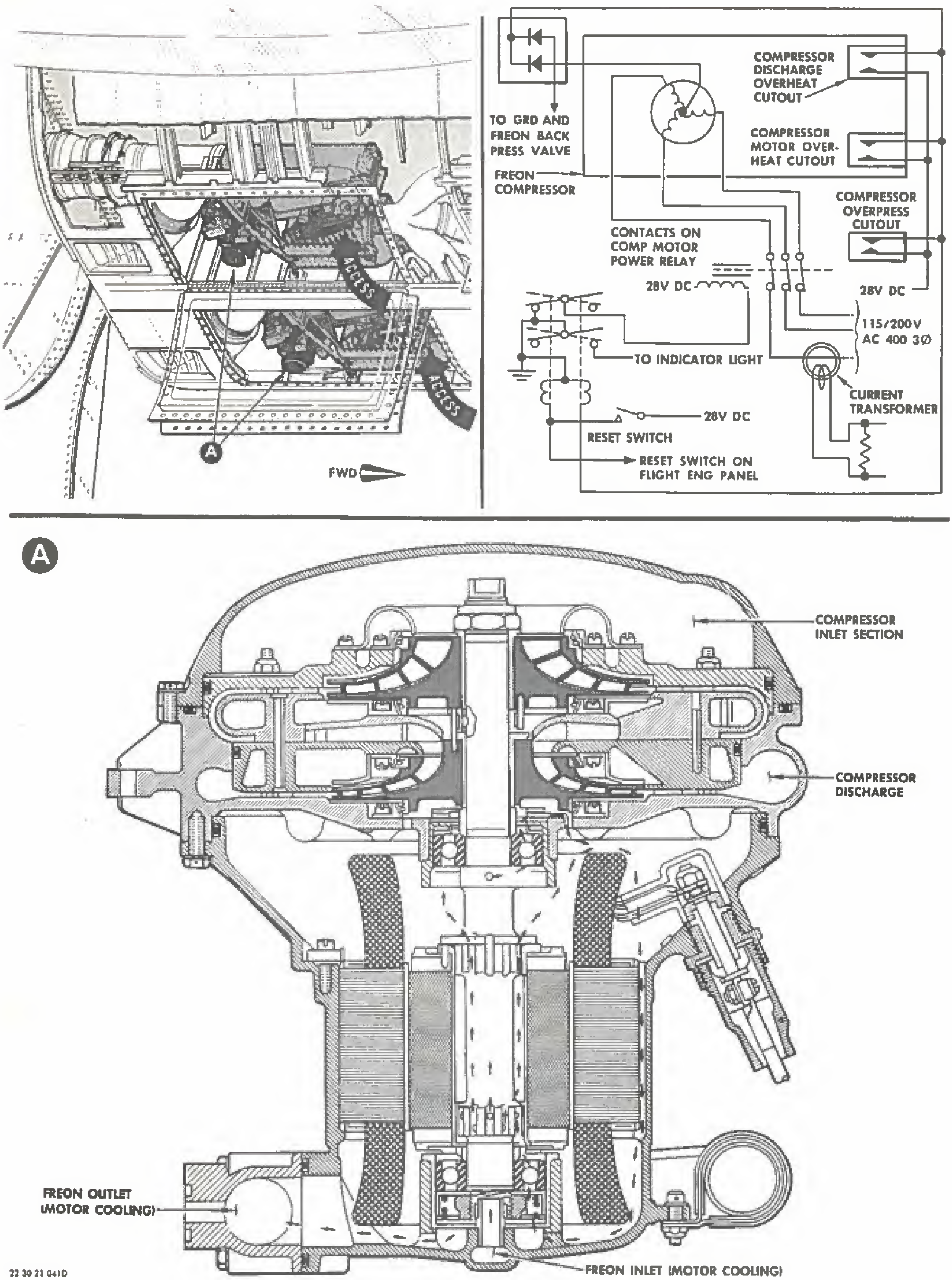
Limited weight flow in the main cooling loop results in compressor surge; a characteristic inherent in centrifugal type compressors. The surge control senses Freon flow and compression ratio at the compressor. It modulates the Freon compressor surge valve whenever the flow and compression ratio approach a predetermined value.

As Freon is recirculated through the compressor by the surge valve, it increases in temperature by picking up the heat of compression. However, this hot gas from the surge valve mixes with the discharge vapor from the compressor motor sump and the mixture passes over the thermal bellows of the expansion valve. The increased temperature of this mixture applied to the thermal bellows of the valve will cause the expansion valve to admit more Freon to the compressor motor housing. Thus, during times of bypass, the compressor motor is over cooled to limit Freon compressor inlet temperatures.

3. Freon Compressor

A. Description.

The Freon refrigeration subsystem uses a two-stage, centrifugal-type compressor driven by an electric motor. As shown in Figure 2, the compressor impellers and the electric motor are mechanically linked by a common drive shaft. The impellers have swept-back blades which permit a wide stable operating range for various compressor flows at a nearly constant compressor speed. The electric motor is a "Y" connected squirrel cage induction motor operating from a 115/200-volt, three-



Freon Compressor
Figure 2

phase, ac power source. Cooling of the motor and lubrication of its bearings is provided by vaporizing liquid Freon, which contains a small quantity of lubricating oil, over these areas. Thermal switches, that sense compressor Freon discharge and motor stator coil temperatures, protect the motor and compressor against excessive temperatures. When either switch actuates, power is terminated to the motor and a signal indicator on the flight engineer's control panel is energized. The Freon compressor is mounted to the support loop of the aft frame. Four Freon ducts, a harness connection, and a junction box with four suction lines attach to the compressor. The compressor assembly consists of a Freon expansion valve and a two-stage centrifugal-type compressor driven by an electric motor. Four power terminals protrude from the side of the compressor motor housing.

B. Operation.

The Freon compressor is utilized for compressing the Freon gas within the Freon package. A hermetically sealed housing encloses the motor and compressor to provide maximum assurance against the loss of Freon or admission of air into the system. Control of the electrical power to the compressor electric motor is provided by a motor power relay. The sequencing device supplies 28-volt dc power to energize the motor power relay whenever Freon compressor operation is scheduled and the backpressure regulating valve is closed. To protect the compressor from damage due to motor overheat, Freon discharge overheat or Freon overpressure, the motor power relay is operated in conjunction with the lockout relay. An additional circuit protects the compressor motor from burning out should one current limiter in the 115/200-volt ac, three-phase power line open. In the event that one leg of the three-phase voltage is lost, current will flow from a center tap on the compressor motor through a rectifying diode to energize the lockout relay. If during compressor operation any of these conditions occur, the relay terminates the 28-volt dc power to the motor power relay to shut down the compressor. A thermister (compressor ground start time delay) is installed in the compressor motor ground relay circuit. The thermister prevents the compressor motor from starting simultaneously with the condenser fan motor when power is supplied to operate the Freon system during ground operation.

The motor cooling expansion valve controls the flow of Freon entering the compressor housing around the electric motor. A bleed orifice within the valve meters sufficient Freon to cool and lubricate the compressor motor and bearings during normal operation. When additional cooling of the motor and bearings is necessary, a poppet valve within the expansion valve opens and allows more Freon to enter the housing. The poppet valve is controlled by a thermal bellows contained with the expansion valve. The bellows portion of the expansion valve extends into the compressor bypass duct and is acted upon by the Freon leaving the motor housing and the Freon bypassed by the surge control valve.

The thermal bellows contains the same type refrigerant as that used in the package and is affected by both temperature and pressure of the evaporated gas as it flows past. The pressure of the evaporated Freon gas leaving the motor housing and Freon gas from the surge valve is admitted to the face of the thermal bellows by four ports in the valve housing located above the face of the bellows. Three resultant forces

act on the poppet valve by means of the bellows and the superheat spring, to provide proper cooling as required. A pressure, tending to open the poppet valve, is exerted by the Freon contained in the bellows. A pressure, exerted by evaporated Freon on the face of the bellows, and the force of the superheat spring tend to close the poppet valve. If the cooling load of the motor increases, the temperature of the evaporated Freon leaving the motor housing increases. This causes the bellows to expand and open the valve, further allowing more Freon to pass into the motor housing in order to carry the higher cooling load. The pressure of the hot Freon gas against the face or the bellows will also increase, tending to close the valve and maintain evaporation at the saturation pressure above the motor. The pressure of the superheat spring tends to close the poppet valve. Its action assures that complete evaporation takes place by slowing down the flow through the motor housing and permitting additional heat to be added to the Freon after evaporation. The thermal bellows of the expansion valve is located in the bypass duct and is subject to high temperature Freon that is recirculated by the surge valve. Thus, during times of surge bypass, the motor is overcooled to permit the Freon from the motor housing to mix with the bypassed Freon and limit compressor inlet temperatures.

4. Freon Condenser

A. Description.

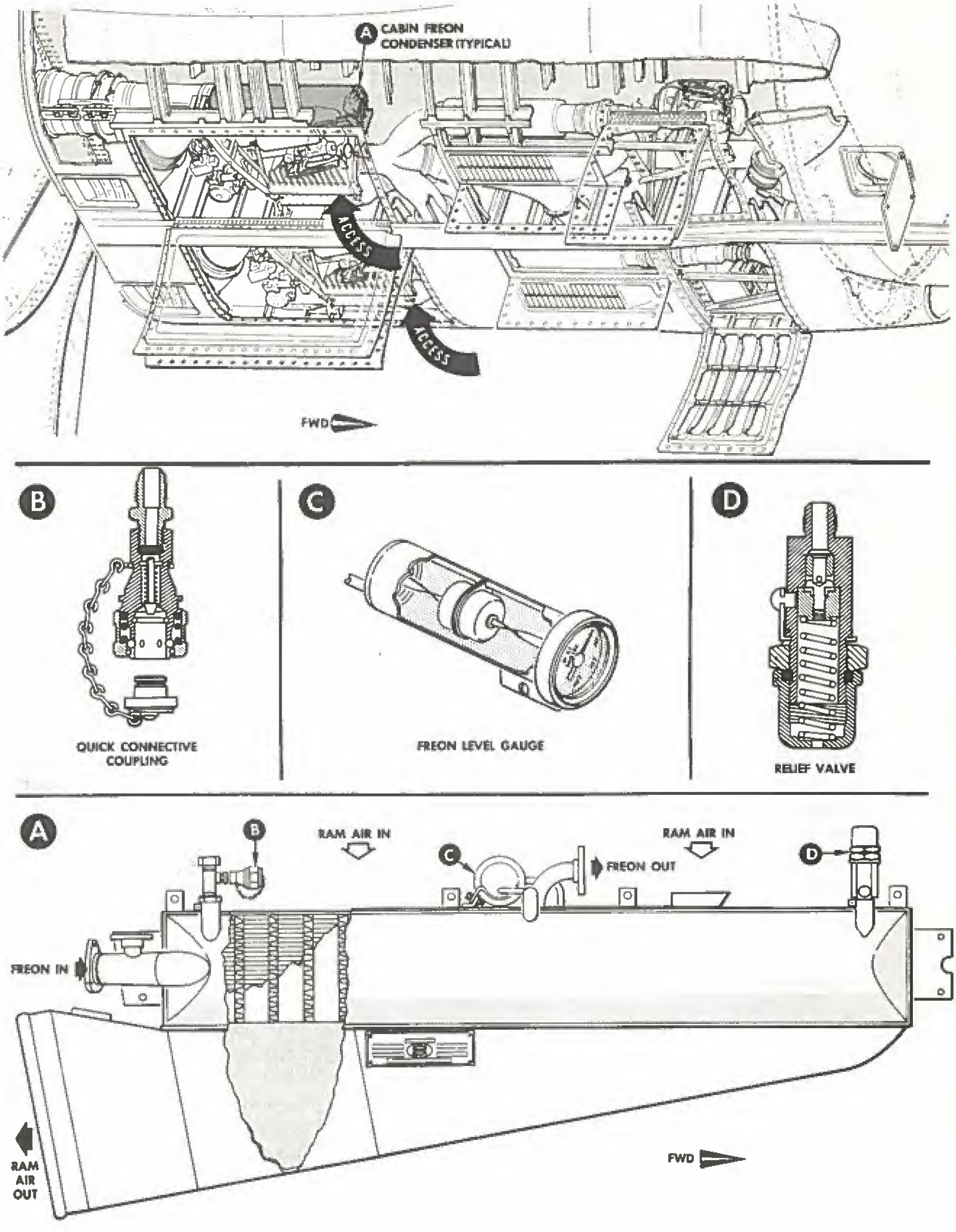
The Freon condenser, shown in Figure 3, consists of a core, purge and drain valves, a relief valve, and a liquid level gage. The ram air inlet is an open side toward the evaporator. A large ram air outlet header provides for duct connection on the aft end of the condenser. The Freon inlet header at the top of the condenser has an inlet port and a bypass port connection aft of the condenser. The Freon outlet is at the base of the condenser, to which the Freon drier and strainer is attached. The condenser core is of the plate and fin design. Below the core is the Freon outlet header which is the Freon receiver at the condenser base.

Quick-disconnect couplings are located at the top and bottom of the condenser. Each coupling consists of a self-sealing socket containing a spring-loaded sliding ring and cap. The ring is manually depressed to permit the insertion of the cap when the coupling is not in use. The cap prevents foreign material from entering the socket.

A relief valve containing a spring-loaded poppet is located at the top of the condenser. A Freon level gage is welded to the condenser base with the gage visible from the lower side of the condenser.

B. Condenser Operation.

The condenser functions as a Freon-to-air heat exchanger and provides for cooling of hot Freon gas under pressure to enable the Freon to condense into a liquid, and subcool it to prevent it from flashing back into a gas before reaching the expansion valve. The hot Freon vapor enters the core at the top and condenses into a liquid while flowing down through the core. The Freon is cooled by the air flowing through the passageways in the condenser core, and by the evaporation of water



22.30.21.040 A

Freon Condenser
Figure 3

which is sprayed over the ram air inlet surface of the core from the evaporator water spray tube.

The quick-disconnect coupling at the top of the condenser is at the highest point in the Freon package and is used for purging air from the package. It can also be used to attach a pressure gage.

The relief valve has a set relief pressure point which is above the normal operating range of the package. It will open to release Freon to atmosphere should a system malfunction cause an excessive pressure differential between the inside and the outside of the condenser. A small rubber plug inserted in the relief valve vent provides a visual indication whether or not excessive pressures have developed. If the plug is blown out of the vent, excessive pressures have occurred and the Freon level should be checked, and the package should be given an operational check. The Freon level gage provides a visual indication of the amount of Freon in the condenser. The liquid Freon in the condenser moves a float which in turn positions a pointer over a graduated dial.

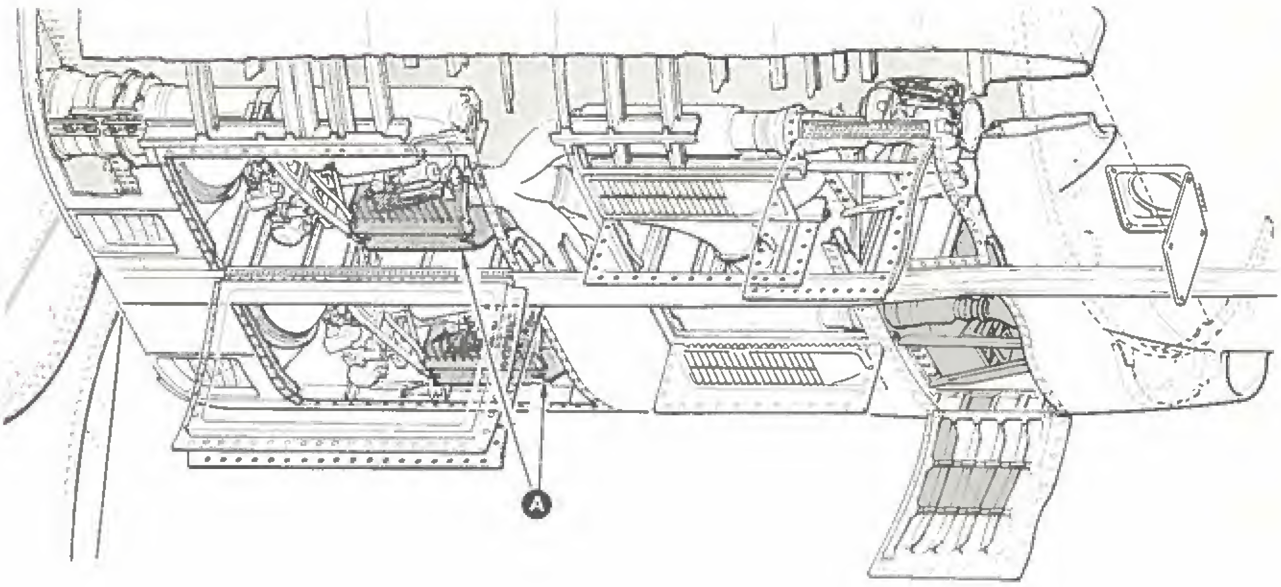
5. Freon Evaporator

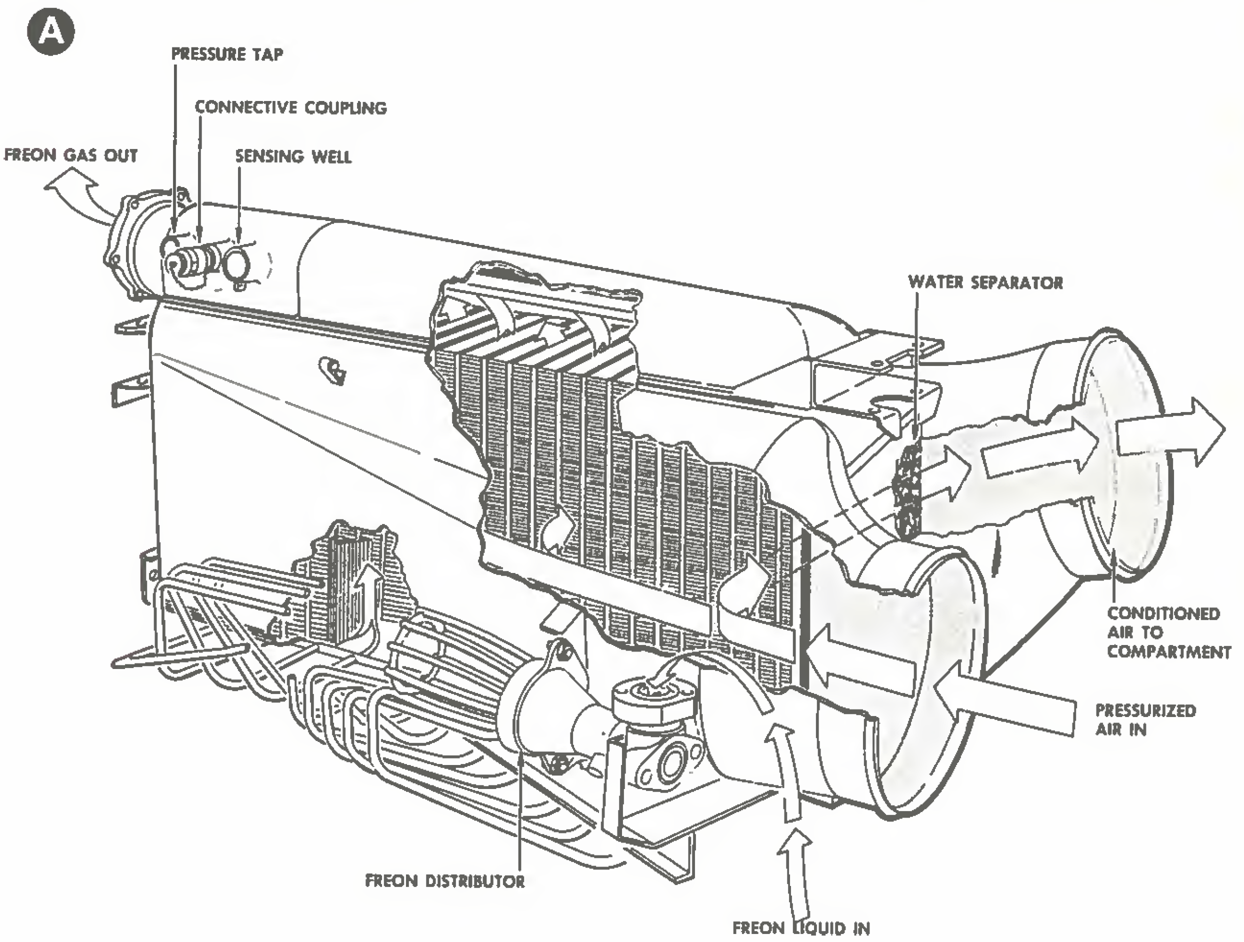
A. Description.

The evaporator, shown on Figure 4, consists of an evaporator core, water separator, and quick-disconnect couplings. Two large air ducts protrude from the forward end of the evaporator body. The Freon inlet is through the expansion valve distributor located near the bottom of the evaporator air inlet header. The Freon outlet header extends to the aft end of the evaporator and connects to the compressor inlet duct. The evaporator core is of the plate and fin design. Pressurized air from the turbocompressor flows in the inlet air duct, through the evaporator core and out through the outlet duct to the compartments. The expansion valve distributor is connected to the evaporator Freon inlet header by twelve tubes. The evaporator core is arranged so that the Freon passages lead from the base to a common Freon collector at the top of the core. The air discharge header contains an aluminum mesh water separator, a water collector, and a drain. The quick-disconnect coupling is located at the top of the evaporator. The coupling consists of a self-sealing socket containing a spring-loaded sliding ring and cap.

B. Operation.

The Freon evaporator acts as Freon-to-air heat exchanger. The pressurized air from the turbocompressor flows horizontally on the outside of the Freon passage walls of the core. The liquid Freon is metered by the expansion valve to the twelve distributor tubes that supply the Freon inlet header at the base of the evaporator. The evaporating Freon, on the inside of the core, extracts heat from the air as it passes over the outside of the core and the air is cooled. Warm Freon gas collects in the collector at the top of the core and is drawn out by the Freon compressor.





Freon Evaporator
Figure 4

As the pressurized air is cooled the dewpoint of the air is reached. Water vapor in the air condenses as water droplets on the core surfaces and drains from the passages into a water collector. Cabin air pressure forces the water from the collector to a spray tube where it is sprayed over the ram air inlet side of the condenser core. Small water droplets are prevented from being blown into the cabin and flight compartments along with the passing conditioned air by the mesh separator which is located in the air discharge side of the evaporator. This mesh separates these small water droplets from the air and allows them to flow down through the mesh to the water drain.

The quick-disconnect coupling provides a means for attaching a pressure gage to observe evaporator Freon outlet pressure. The ring is manually depressed to permit the insertion of the cap when the coupling is not in use. The cap prevents foreign material from entering the socket. The cap is replaced by a standard Hansen 1-K11 plug to open the coupling and permit attachment of the pressure gage.

6. Freon Expansion Valve

A. Description.

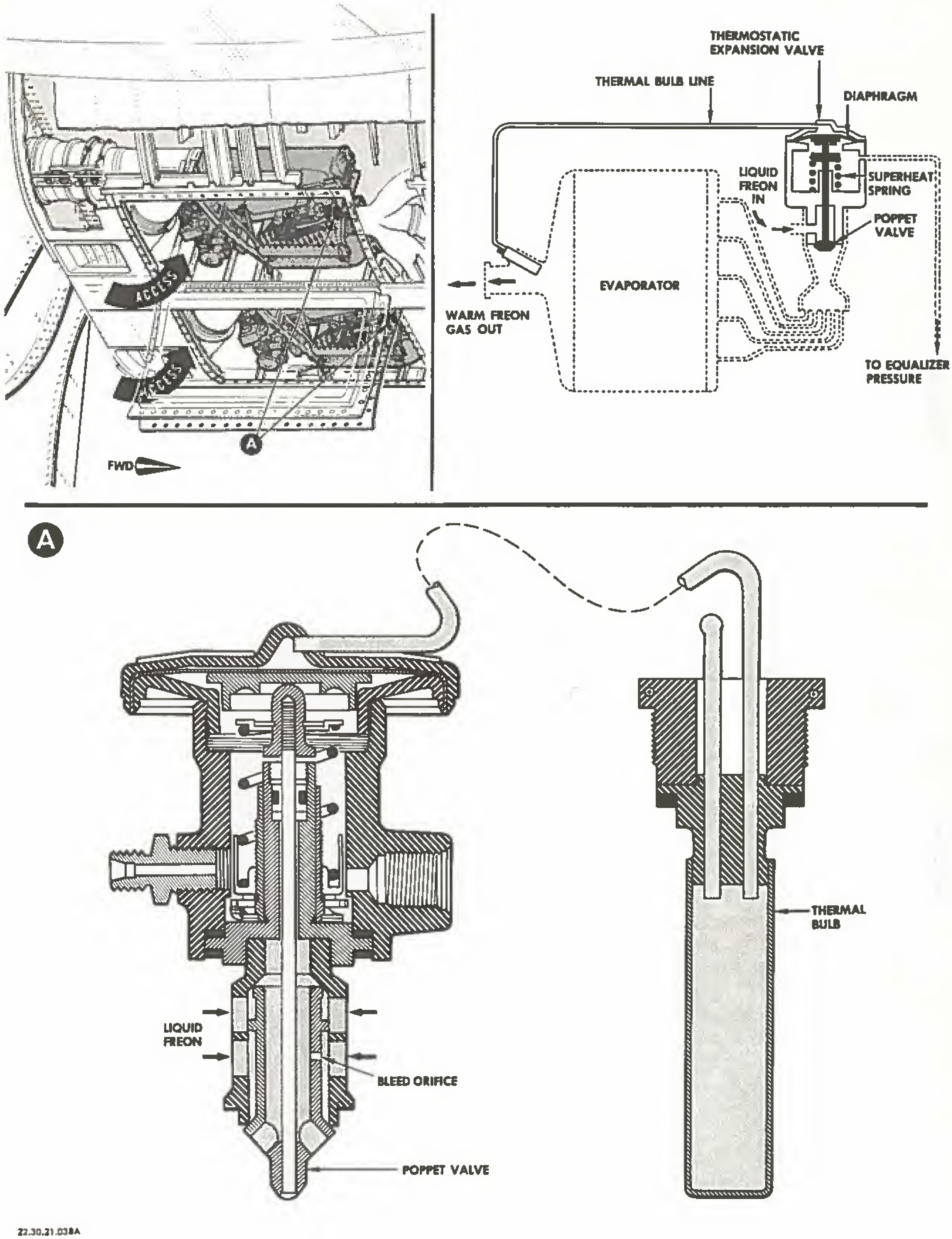
The expansion valve is mounted near the bottom of the evaporator air inlet header. The valve, shown on Figure 5, consists of two basic parts, the thermo valve cage assembly, and the thermo valve actuator and sensor. The cage is contained within the actuator housing and protrudes into the valve distributor head which is a part of the evaporator. A poppet with a bleed orifice is contained within the valve body and is spring-loaded to the closed position by a superheat spring. The actuator and sensor has a sensing line which is connected to a thermal sensing bulb in the evaporator Freon outlet header and to a sealed chamber behind a metal diaphragm. This sealed unit contains Freon isolated from the rest of the Freon in the refrigeration system. The upper end of the poppet shaft contacts the lower surface of the diaphragm of the actuator and sensor. An equalizer line connects the spring chamber to the outlet header on the evaporator.

B. Operation.

In the main cooling loop, the Freon expansion valve regulates the flow of liquid Freon through the evaporator so that it leaves the evaporator completely evaporated and superheated.

(1) Definition of Superheat.

Superheat of the Freon gas is expressed in degrees. It is the temperature increase above saturation temperature at the existing pressure. For example, an evaporator operating with Freon 114 at 13.7 psia outlet pressure will have a saturation temperature of 35 degrees F. As long as the boiling Freon at any given point in the evaporator exists at this pressure, the temperature at that point will remain at 35 degrees F. As the liquid Freon moves along in the core of the evaporator, the liquid is boiled into a vapor by



Freon Expansion Valve
Figure 5

the heat it extracts from the conditioned air. The gas continues to the end of the evaporator core under the same pressure of 13.7 psia; however, its temperature increases due to heat pickup after boiling is completed while travelling to the end of the core and its temperature becomes 45 degrees F. The gas is considered to be superheated and the amount of superheat is 10 degrees F. Superheat is added to the Freon in the evaporator to assure complete evaporation of the liquid Freon and to prevent liquid Freon from entering the compressor.

(2) Poppet Valve and Diaphragm Operation.

The poppet valve is linked to a diaphragm which is exposed on one side to evaporated Freon gas pressure from the equalizer line. The opposite side of the diaphragm is exposed to pressure from an independent mass of gaseous Freon contained within the thermal bulb circuit. The pressure exerted on the diaphragm by the gas pressure from the equalizer line tends to close the poppet valve, while on the opposite side, pressure from the thermal bulb circuit tends to open the poppet. Thus, three forces act to operate the poppet valve: 1) the force from the Freon in the thermal bulb circuit created by the temperature of the evaporated Freon as it leaves the evaporator, 2) the force exerted by evaporator pressure through the equalizer line, and 3) the force from the superheat spring. The three forces on the diaphragm attain a point of balance for operation. When the evaporator is operating at a temperature of 35 degrees F or a pressure of 13.7 psia, and the Freon gas leaving the evaporator at the thermal bulb location is 45 degrees F, a condition of 10 degrees F superheat exists. Since the thermal bulb circuit is charged with Freon 114, its pressure will follow the saturation pressure-temperature characteristics of the Freon package. With the thermal bulb at 45 degrees F, the pressure exerted against the diaphragm by the thermal bulb circuit will be 17 psia and will tend to open the poppet valve.

On the opposite side of the diaphragm and acting to close the poppet valve are the evaporator pressure from the equalizer line (13.7 psia) and the force of the superheat spring (equivalent to a 10 degree F superheat setting of 3.3 psia). Thus, the valve is in balance with 17 psia above the diaphragm and the equivalent of 17 psia below the diaphragm. If the cooling load through the evaporator increases, the temperature of the Freon at the outlet of the evaporator increases. The pressure in the thermal bulb circuit increases because it is sensing a higher temperature. This increased pressure opens the poppet valve, further allowing more Freon to pass in order to carry the higher cooling load and maintain a relatively constant superheat. Conversely, a decrease in the cooling load of the evaporator will cause the poppet valve to move in a closing direction.

When the Freon package is shut down and the Freon compressor is stopped, the pressure in the evaporator starts to build up and tends to equalize the pressure of the thermal bulb circuit. This increase in evaporator pressure and the force of the superheat spring

overcomes the pressure of the thermal bulb circuit and closes the poppet valve. This function is important for it prevents the evaporator from becoming flooded with liquid Freon whenever the Freon package is shut down.

7. Motor Cooling Expansion Valve

A. Description.

The expansion valve for the motor cooling loop is an integral part of the Freon compressor; it provides control of the Freon entering the compressor housing about the electric motor. The valve, shown schematically on Figure 6, consists of a thermal bellows linked to a poppet valve which contains a bleed orifice. The poppet valve is spring-loaded by a superheat spring. The portion of the valve which contains the thermal bellows is located in the discharge duct of the compressor bypass and motor housing. Thus, the bellows is subjected to temperatures of the Freon leaving the motor housing and that Freon which is bypassed by the surge control valve. The thermal bellows is filled with Freon and is affected by temperature and pressure of the evaporated gas.

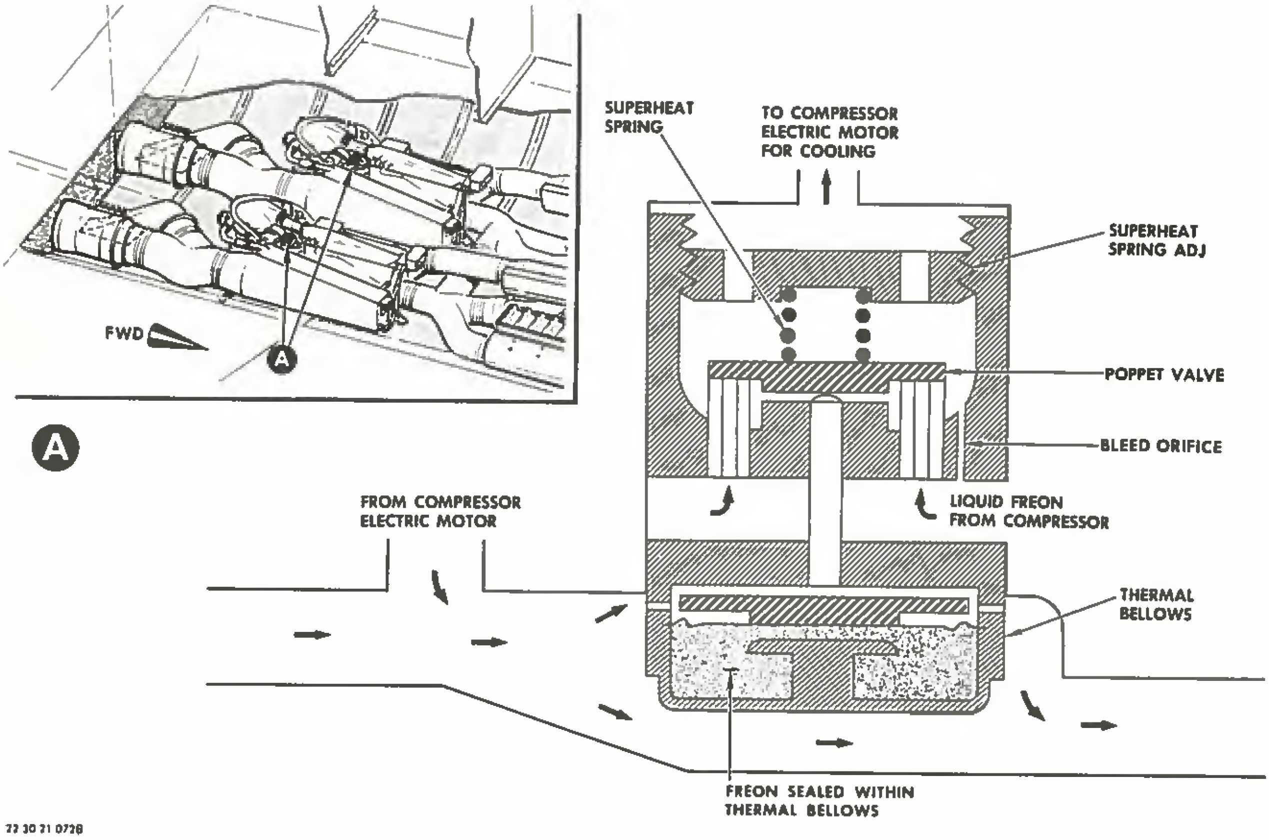
B. Operation.

Normal cooling of the motor is provided by Freon flow through the bleed orifice in the poppet. During above normal cooling requirements and surge bypass conditions, additional cooling of the motor (above that provided by Freon flow through the orifice) is accomplished by Freon flow through the open poppet. By means of the bellows and superheat spring, three resultant forces act on a pilot valve to provide the motor cooling required: 1) a pressure which tends to open the poppet valve is exerted by the Freon in the bellows, 2) a pressure to close the poppet valve is exerted by the evaporated Freon on the face of the bellows, and 3) by the superheat spring. If the cooling load of the motor increases, the temperature of the evaporated Freon leaving the motor housing increases. This temperature increase causes the bellows to expand and open the poppet valve further, allowing more Freon to pass into the motor housing to carry the higher cooling load. The pressure of the Freon leaving the housing acts against the face of the bellows tending to close the poppet valve and maintain evaporation about the motor at saturation pressure. The action of the superheat spring in closing the poppet valve assures complete Freon evaporation. This is accomplished by slowing the Freon flow through the housing and permitting additional heat to be added to the Freon after evaporation.

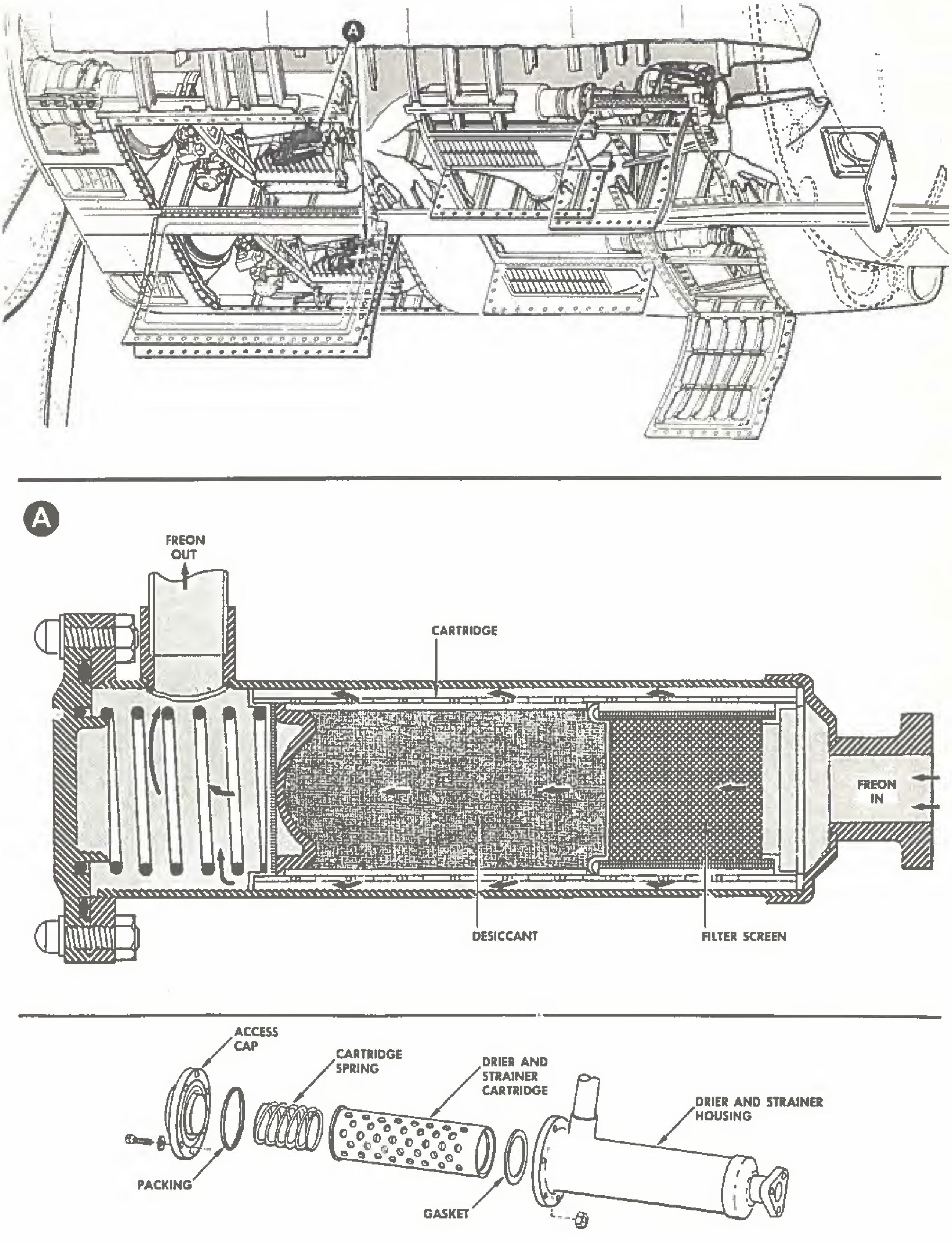
8. Freon Drier and Strainer

A. Description.

The Freon drier and strainer, shown on Figure 7, is a cylindrical unit that consists of a housing, a cartridge consisting of a can shaped filter screen filled with a chemical desiccant, an access cover, and outlet ducting. The housing has a mounting flange on one end for mounting to the condenser. The Freon outlet end of the housing is connected to a



Motor Cooling Expansion Valve
Figure 6



22 30.21.062 A

Freon Drier and Strainer
Figure 7

loop formed duct which connects to the evaporator Freon inlet port flange. The Freon passes through the strainer and drier cartridge where foreign material is removed by the strainer and traces of moisture and removed by the desiccant.

9. Back Pressure Regulator Valve

A. Description.

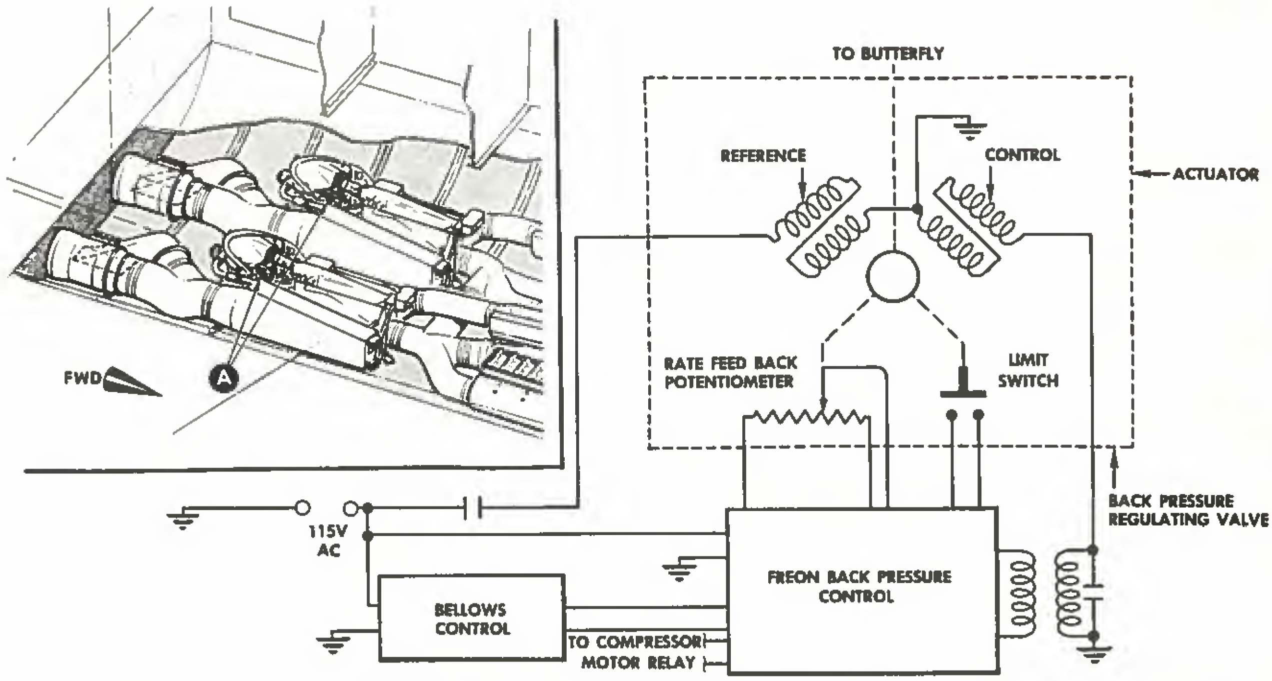
The back pressure regulator valve is mounted on the compressor at the compressor inlet. The valve, shown on Figure 8, consists of a housing containing an electric actuator splined to a valve shaft which is attached to a butterfly. The electrical actuator directly drives the valve butterfly and is hermetically enclosed within the valve housing. This hermetically sealed chamber is drained to compressor inlet suction to eliminate Freon seepage from around the butterfly shaft. The actuator contains an electric motor mechanically coupled to a rate feedback potentiometer and a limit switch. The limit switch closes whenever the butterfly is in the closed position.

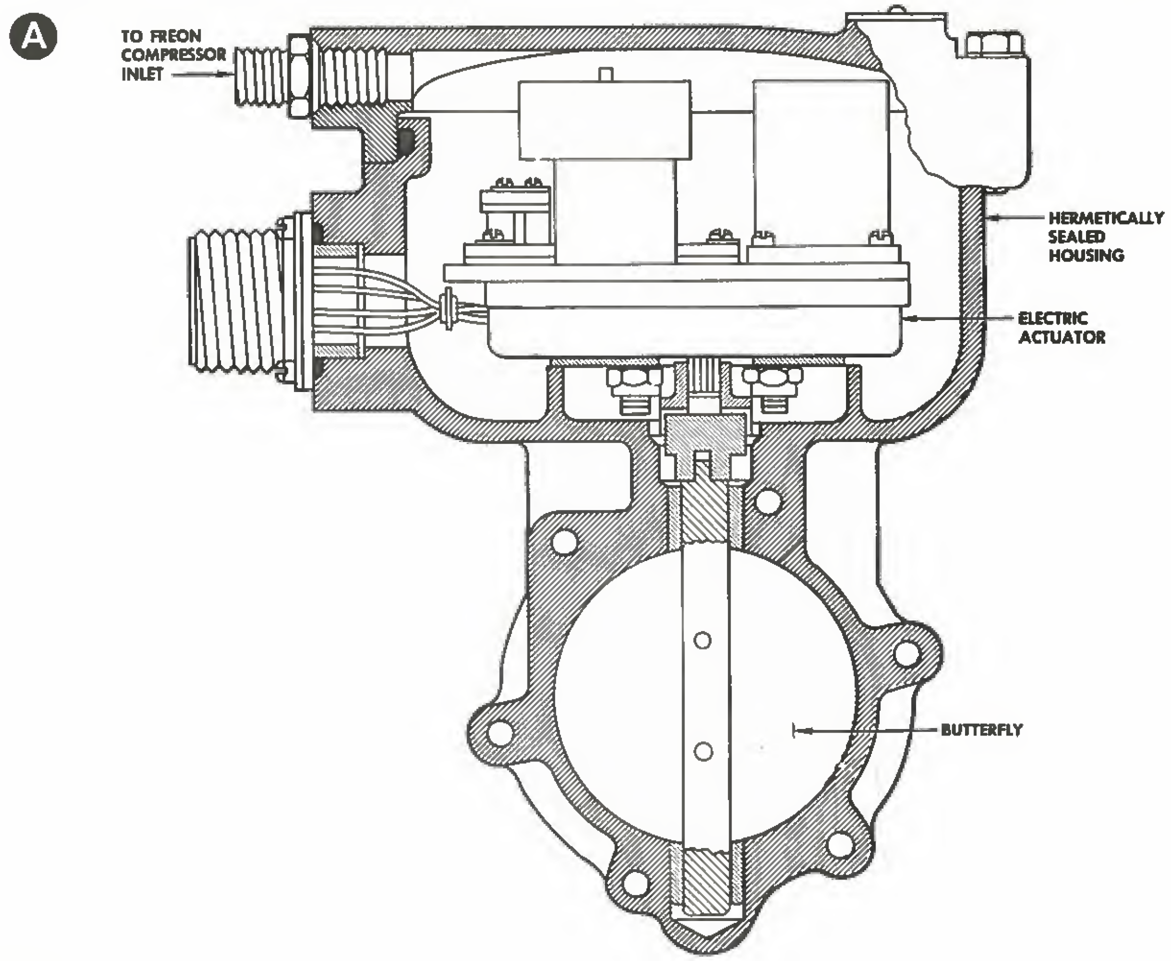
B. Operation.

The valve actuator is operated by an electric servo motor having two phase windings. Motor rotation is determined by the difference between phase shifts of ac voltage applied to each winding. One phase winding is used as a reference voltage winding with an ac voltage from a power source connected to it. The other phase winding is used as a control winding and the phase of the voltage applied either leads or lags that phase at the reference winding. By having the control voltage phase lead that of the reference voltage phase, motor rotor rotation is in a given direction. Changing the control voltage phase so that it lags the reference voltage phase will result in motor rotor rotation in the opposite direction. 115-volt ac power is capacitance coupled to the reference phase winding as reference voltage at all times. Control phase voltage is applied to the control phase winding as required to modulate the valve.

When Freon package operation is not scheduled, control voltage is applied continually to keep the valve closed. When package operation is scheduled, control voltage is applied by the electronic back pressure control to schedule valve position as required by the sequencing device. However, at the start of Freon package scheduling, the back pressure regulator valve must be closed so that its limit switch is in the closed position. The limit switch completes a circuit which permits the Freon compressor to start. Once the compressor is operating the switch is no longer utilized to complete the compressor relay circuit. When the compressor is shut down, a 28-volt dc bias is applied to the back pressure control to drive the back pressure regulator valve closed, closing the limit switch to allow system restart.

A signal is supplied from the bellows control to the back pressure control to provide either a leading or lagging phase control voltage to modulate the valve as scheduled by the sequencing device (positions the





22.30.21.037A

Back Pressure Regulator Valve
Figure 8

bellows control). The rate feedback potentiometer of the actuator provides a signal to the control so that it may regulate the rate of travel of the electric motor of the actuator.

10. Bellows Control

A. Description.

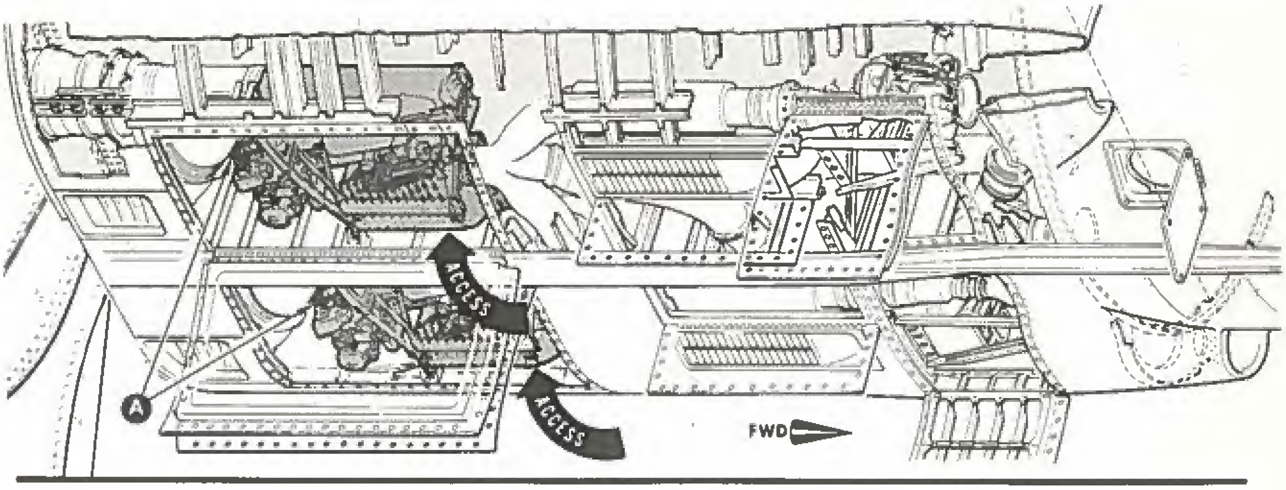
The bellows control is bracket-mounted to the aft frame of the Freon package near the condenser ram air outlet header. A harness receptacle and four pressure lines connect the control to the system. The bellows control, shown on Figure 9, consists of two bellows within separate chambers, a cam follower, and a reluctance transformer. A sequencing device is connected to the bottom of the bellows control. A harness connects the reluctance transformer to the lockout relay and the back pressure control. An evaporator outlet pressure line leads into one chamber and a line from the surge bypass duct leads into the other. Each chamber has a Freon drain tube leading to the compressor junction block. The cam follower protrudes from the control bottom for contact with the sequencing device. The cam connects internally through a spring load to a double bellows in the evaporator pressure chamber. A lever arm connects the double bellows to the single bellows and transformer in the compressor pressure chamber.

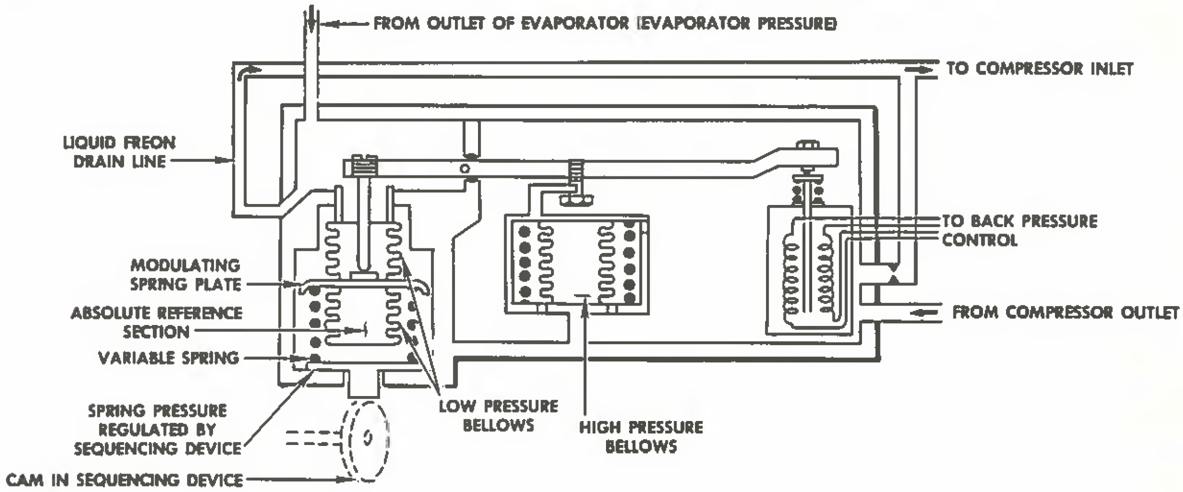
B. Operation.

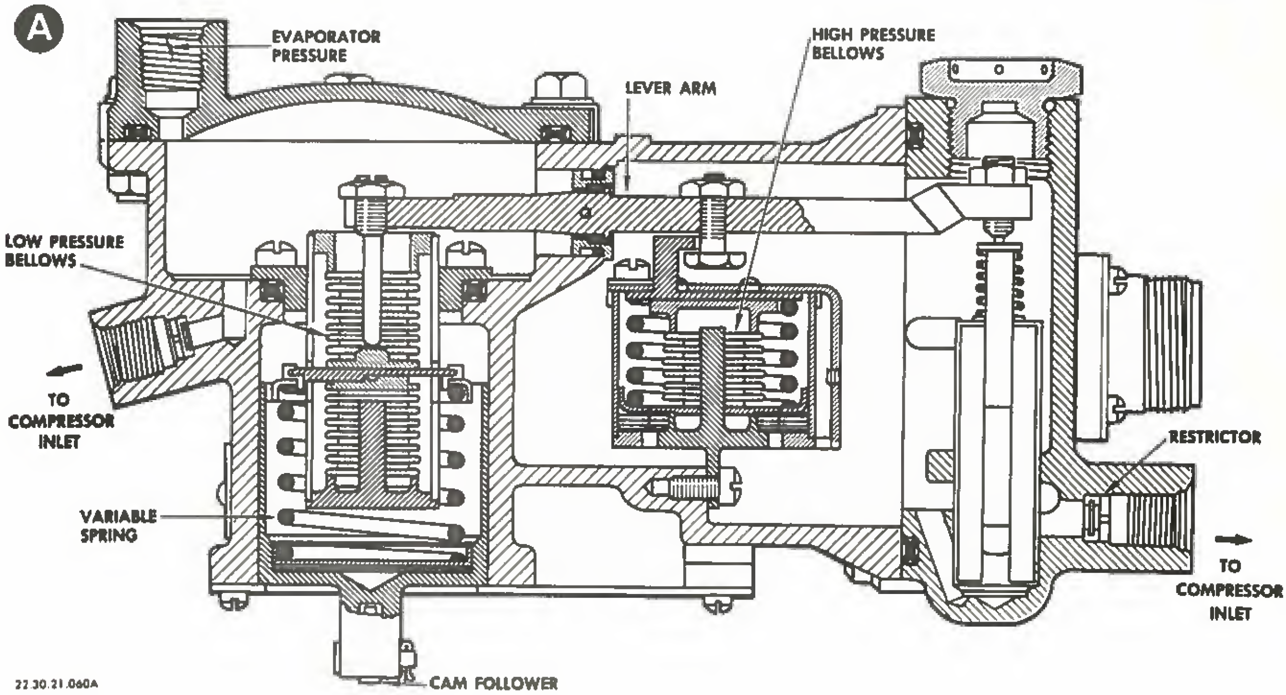
The bellows control contains a high and low pressure bellows, a cam regulated spring and a modulating spring plate linked to a reluctance transformer and a lever. The bellows control provides a signal to the back pressure control that is translated into control phase voltage by the back pressure control and applied to the back pressure regulator valve to regulate the Freon system cooling capacity.

Besides controlling the system cooling capacity, the bellows control also limits the minimum Freon pressure in the evaporator and the maximum outlet pressure of the compressor. Minimum evaporator pressure is maintained above a saturation temperature of 30 degrees F so that freezing of condensate on the air side of the evaporator core will not take place. Outlet pressure of the compressor is limited to a predetermined value to limit compressor motor loads.

Freon pressure taken from the outlet of the evaporator is bled into one section of the low pressure bellows to exert pressure on one side of a modulating spring plate. This pressure is compared to a force on the opposite side of the plate consisting of the absolute reference section of the low pressure bellows and a spring pressure from a variable spring. The pressure exerted by the variable spring is controlled by a cam in the sequencing device. The sequencing device regulates the spring force in relation to the demands of the temperature control. The modulating spring plate operates the reluctance transformer. Freon compressor outlet pressure is ducted to a high pressure chamber in the control containing the high pressure bellows and the reluctance transformer. The high pressure bellows is coupled to the reluctance transformer. The







Bellows Control
Figure 9

high and low pressure chambers of the bellows control are ducted to the compressor inlet through choked orifices. These compressor inlet lines tend to prevent the formation of liquid Freon in the chambers and provide a drain should liquid Freon form.

(1) Increase in Cooling.

When the temperature control signals for an increase in compartment cooling, the sequencing device cam rotates to decrease spring force on the modulating spring plate. This permits Freon pressure from the evaporator to move the spring plate against the reduced spring force. Movement of the spring plate in this direction causes the reluctance transformer to provide a signal to the back pressure control which further opens the back pressure regulator valve. The opening of the back pressure regulator valve decreases evaporator pressure. This results in decreased saturation temperature in the evaporator so that increased cooling of the air takes place. As evaporator pressure decreases, less pressure is applied to the low pressure bellows, resulting in a reduction of the "open" signal from the reluctance transformer. The changed evaporator pressure serves as a feedback signal, tending to halt the opening of the back pressure regulator valve and thereby setting the evaporator at the new low pressure. This action of the bellows control produces a steady state condition between evaporator pressure and the amount of spring pressure that is being applied by the position of the sequencing device cam.

When the temperature control signals for full cooling capacity from the Freon package, the sequencing device is rotated so that its cam allows the cam follower to come to rest on the minimum temperature stop. The resulting spring pressure is sufficient to maintain Freon evaporator pressure above the Freon saturation pressure corresponding to 30 degrees F. Thus, freezing of condensate on the evaporator will not take place.

(2) Decrease in Cooling.

When the temperature control signals for a decrease in compartment cooling, the sequencing device cam increases spring pressure on the modulating spring plate. This moves the core of the reluctance transformer providing a signal which results in closing the back pressure regulator valve. Closing of the valve increases evaporator pressure which balances the new spring force on the modulating spring plate and does not allow the valve to go full closed. When the spring pressure against the modulating spring plate equals the evaporator pressure against the opposite side of the spring plate a steady state condition exists.

The evacuated section of the low pressure bellows provides an absolute reference for the evaporated Freon pressure against the face area of the low pressure bellows. The inclusion of this evacuated section prevents the low pressure bellows from being affected by

changes in atmospheric pressure by isolating the face area from ambient. This method assures that minimum saturation pressure with the evaporator, as determined by the adjustment of the minimum temperature stop, will be the same at all altitudes.

Should the compressor outlet pressures become excessive due to a malfunction in the vapor cycle system, pressure surrounding the high pressure bellows causes it to start compressing. Compressing the bellows moves the core of the reluctance transformer in a direction to provide a signal to the back pressure control which tends to close down on the back pressure regulator valve thereby reducing compressor outlet pressure. Should compressor outlet pressure reach 160 psia, an overpressure switch (external to the bellows control) actuates and shuts down the Freon compressor.

11. Freon Compressor Surge Valve

A. Description.

The compressor surge valve is mounted on the housing of the compressor where the compressor bypass inlet joins the surge bypass tube. The valve, shown on Figure 10, contains a spring-loaded poppet valve attached to a diaphragm operated piston. A control tube is ducted to the chamber formed between the diaphragm and the valve cap. The chamber is connected to the valve outlet flange through an orifice in the valve body. The poppet is spring-loaded in the valve open position.

B. Operation.

The compressor surge valve provides Freon flow between compressor outlet and inlet at times of limited Freon weight flow through the normal cooling loop. The diaphragm chamber is supplied with servo pressure from the surge control to close the poppet valve. The servo pressure within this chamber is bled off through the choked orifice to the compressor inlet. When compressor weight flow decreases to a minimum acceptable value, the resulting decreased servo pressure against the servo valve diaphragm permits the spring to move the diaphragm. This action opens the poppet valve to recirculate Freon through the compressor and prevent compressor surging.

12. Freon Compressor Surge Control

A. Description.

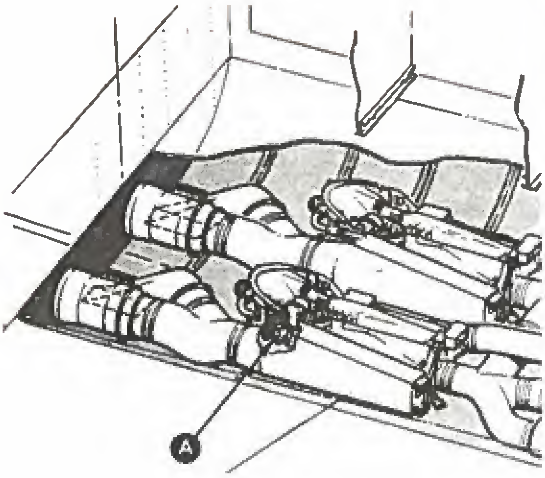
The surge control is mounted to the compressor outlet with a control line to the surge valve and an inlet pressure sensing line connected to the compressor junction block. The Freon compressor surge control, shown on Figure 11, consists of two diaphragm separated chambers, a poppet valve, and a piezometer ring and probe. A central adjustment boss contains a seal, adjusting screw, and cap on one side, and a sealing diaphragm on the other. The central chamber, located between the two diaphragms, is connected to the probe in the pickup flange. The

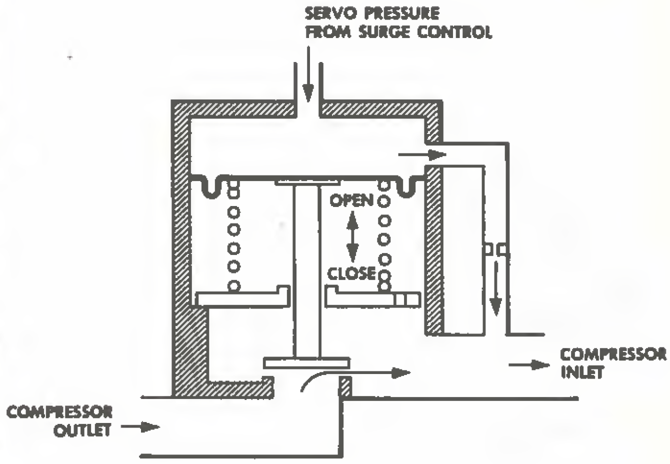
lower chamber is between the large diaphragm-operated piston and the poppet valve. The piezometer ring, which measures static pressure, is connected to this chamber. The poppet valve is spring-loaded to the closed position. When held open, it connects compressor outlet pressure to the surge valve.

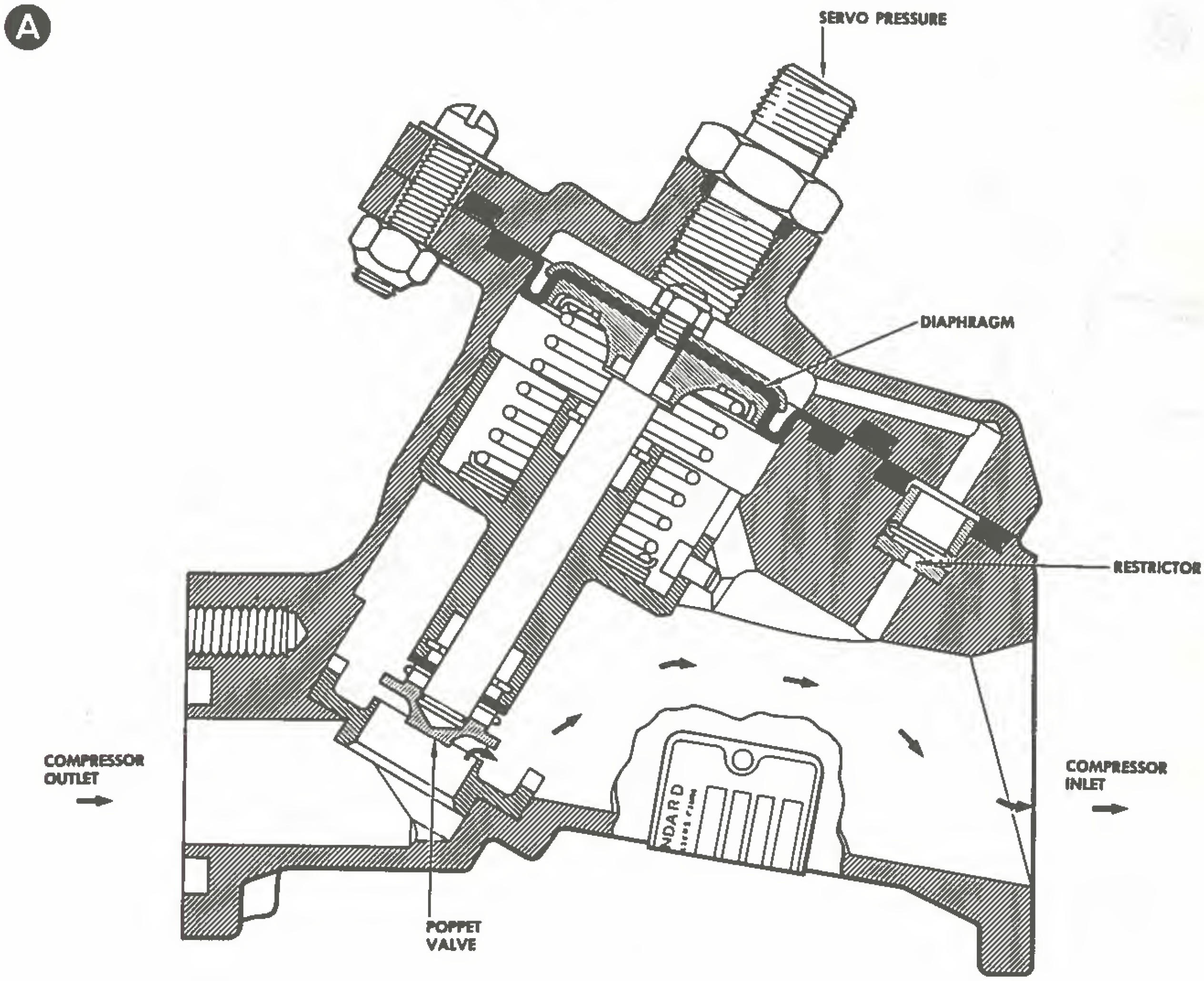
B. Operation.

The surge control senses Freon flow through the main cooling loop at the compressor outlet to modulate the Freon compressor surge valve whenever compressor flow is reduced to a predetermined value. Total compressor outlet pressure is picked up by a probe and supplied to the center chamber between the two diaphragms.

Static pressure obtained by compressor outlet flow through a piezometer ring is supplied to the chamber isolated by the large diaphragm. Static compressor outlet pressure, through a separate channel, is applied to the poppet valve for regulation as servo pressure for the surge valve. Movement of the diaphragm is caused by the difference between pressures in the chambers. Total pressure is always greater than static pressure, and their pressure differential increases as the weight flow increases. The area of the diaphragm is so established that the resultant combination of total and static pressures will tend to close the poppet valve whenever critical weight flows are approached.

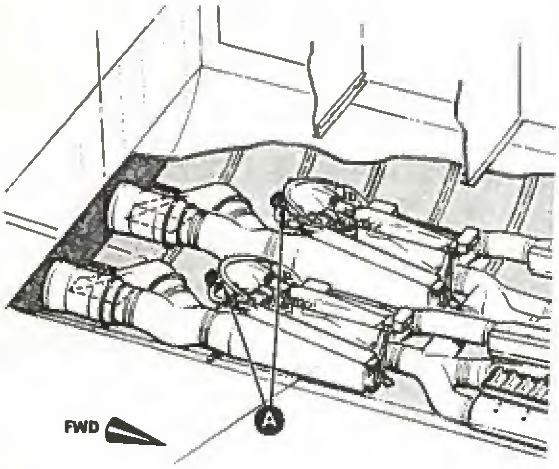


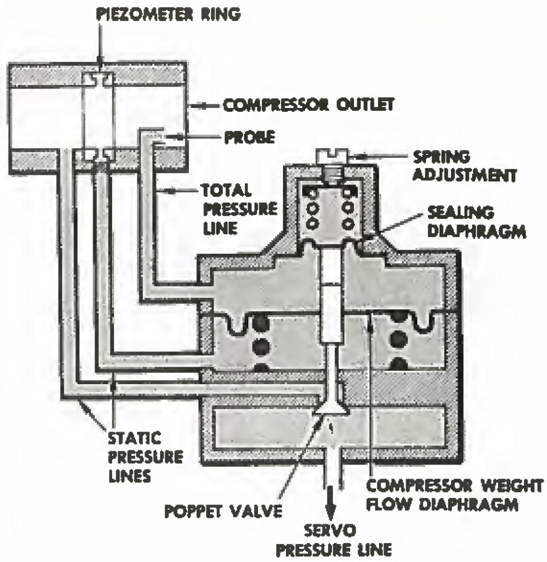


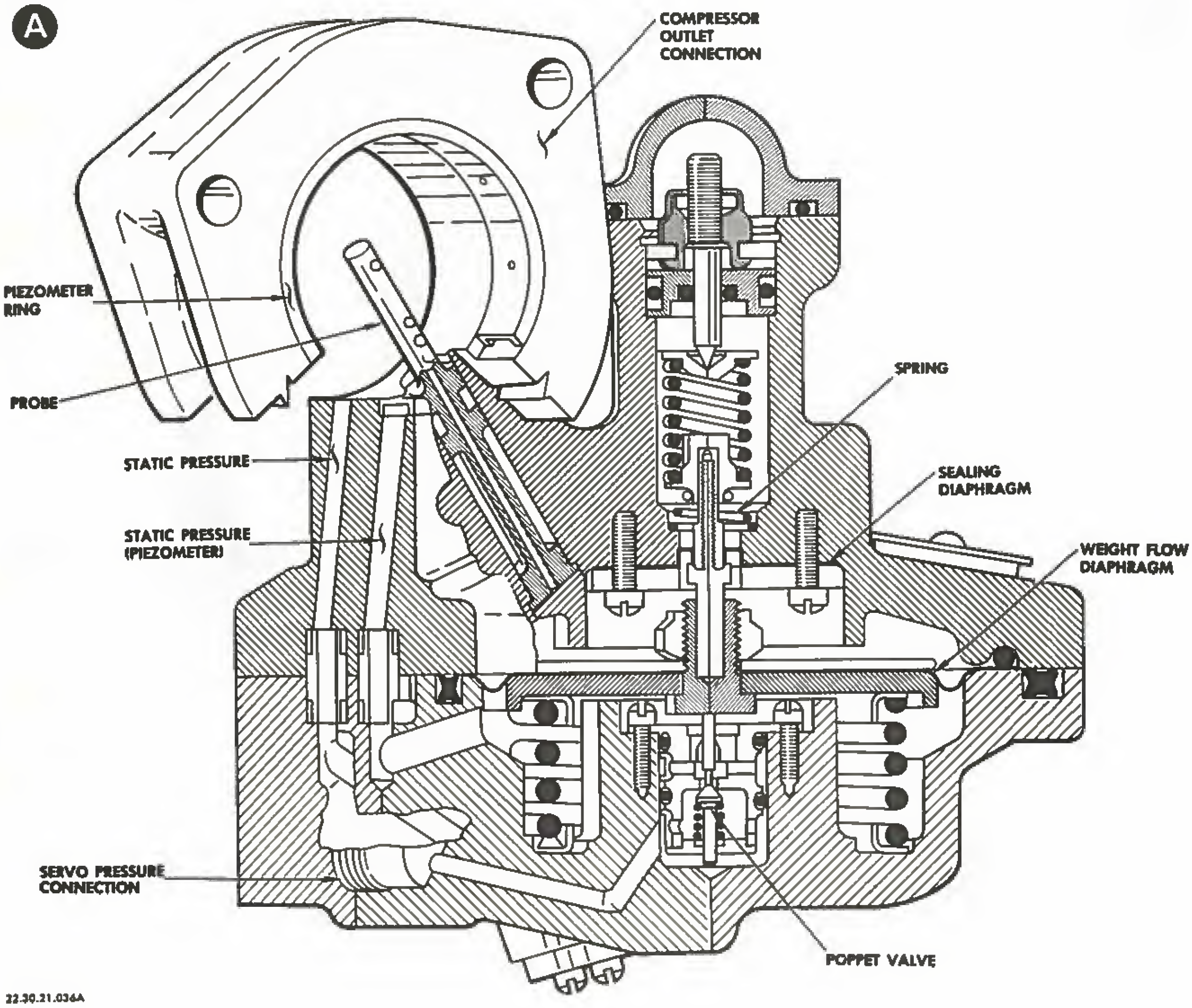


22.30.21.082

Freon Compressor Surge Valve
Figure 10







Freon Compressor Surge Control
Figure 11

FREON PACKAGE - TROUBLE SHOOTING

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION
1. FREON FAIL LIGHT IS "ON" (Lockout relay or compressor overspeed control has tripped)	
A. Loss of Freon.	Check Freon liquid level in condenser. If level indication is low, recharge Freon package, adding oil if necessary. If the gage indicates below "0" the Freon package should be removed and replaced. Reset overspeed control and lockout relay.
B. Compressor motor relay malfunction or loss of 115/200-volt ac.	Check for continuity from pins A to B of the Freon compressor motor relay. Measure voltage from T_1, T_2, T_3 to ground for 115/200-volt ac. If not correct voltage, check current limiters on NO. 2 AC ESS BUS. Replace limiters as needed. With the disconnect plug to the Freon compressor motor relay removed place a jumper from pin B of the relay to ground, and apply 28-volts dc to pin A. The relay should close and the Freon compressor motor should start. If not, check continuity of airplane wiring to compressor motor. Repair as necessary.
C. Lockout relay malfunction.	Reset lockout relay and attempt a start of the Freon compressor motor. If the unit will not start check that lockout relay is in the open position, thus removing the ground from the Freon compressor motor relay. If the lockout relay will not "reset", remove the larger plug from the lockout relay. Check for continuity between pins: F to C, compressor discharge overpressure switch, G to T, compressor motor overheat switch, H to S, compressor discharge overtemp switch; if any of these are closed, remove and replace the malfunctioning unit. If the compressor will not start, check for an open Freon compressor ground start time delay (thermister). If no continuity through a resistance is found, repair wiring or remove and replace time delay thermister.

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION
1. FREON FAIL LIGHT IS "ON" (Lockout relay or compressor overspeed control has tripped) (CONT)	
D. Inadequate temperature drop across the Freon expansion valve.	Check the temperature of the compressor motor sump and check to see if a temperature drop exists across the expansion valve. If no appreciable temperature drop shut down the compressor immediately if the compressor discharge overheat switch has not already done it. The malfunction is due to a failed "closed" expansion valve or a plugged drier or strainer. Remove and replace the Freon compressor package.
E. Inadequate cooling of the condenser.	Freon compressor operates but package shuts down after a short time. The malfunction is due to improper condenser cooling. Check the operation of the condenser fan, condenser ground cooling valve, air shutoff valve, and the condenser cooling air modulating valve. Remove and replace the malfunctioning unit after checking its operation with GS-1278.
F. Improper regulation of Freon back pressure valve.	Place an AC ammeter in one leg of the 115/200-volt ac line to the Freon compressor motor. Adjust the sequencing device for full cooling; the ammeter should not read more than 88-amps (measuring between terminals A and B of the current transformer, and AC voltmeter should read 8.67-volts rms). NOTE: Be sure that the Freon compressor is working under maximum compression. If above this value the Freon back pressure valve should be adjusted. If the correct voltage cannot be attained remove and replace the back pressure control.
G. Freon compressor motor overheats.	If the Freon compressor operates but shuts down when operated in minimum cooling with surge bypass functioning, the trouble is a failed "closed" motor cooling expansion valve. Replace Freon package.

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION
2. FREON COMPRESSOR WILL NOT START (Lockout relay not tripped)	
A. Open limit switch circuit in Freon back pressure valve.	Remove the power plug from the back pressure regulator valve and check for continuity between terminals A and H of the valve regulator. If open, use back pressure control test set GS-1279 and check for reference and control voltages. If no reference or control voltages, remove input plug to back pressure control, and check for 115-volt ac between pins C and D of the removed plug. If 115-volt ac is present, remove and replace back pressure control.
B. Loss of 115-volt ac to control unit.	If no 115-volt ac present at the input to the back pressure control unit, remove the outlet plug from the lockout relay. Check between E to K of the lockout relay receptacle. If voltage exists, the trouble is between the lockout relay and the back pressure regulator, repair wiring as necessary. If no voltage remove the input plug to the lockout relay and measure between pins R and M of the removed plug. If the correct voltage exists, the trouble is in system control. (Refer to Section 21-0, Trouble Shooting.) If 115-volt ac is present, trouble is in the lockout relay, remove and replace.
C. Loss of circuit control to back pressure regulator.	Remove the input plug to the back pressure control and check for continuity between terminals A and B of the receptacle. If continuity is complete, trouble is in the lockout relay or in the wiring between units. Repair as necessary. If continuity is open, the trouble is in the control; remove and replace.
D. Back pressure regulating valve malfunction.	If reference and control voltage are correct, monitor position of valve with test set GS-1279. If valve closes limit switch is defective. Remove and replace Freon package. If the valve does not close the malfunction is within the back pressure valve, remove and replace Freon package.

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION
2. FREON COMPRESSOR WILL NOT START (Lockout relay not tripped) (CONT)	
E. Malfunction in the back pressure control.	Remove input plug to back pressure control (small plug) and check for 28-volt dc from pin E to ground. If voltage is present, remove and replace back pressure control. If voltage is not present, remove output plug from lockout relay and check for 28-volt dc from pin W to ground. If voltage is present the trouble exists in the harness between the lockout relay and the back pressure control, repair as necessary. If the correct voltage does not exist, remove the plug to the lockout relay and measure between pin H to ground of the removed plug for 28-volt dc. If no voltage the malfunction is in system control. (Refer to 21-0, Trouble Shooting.) If 28-volt is present, the malfunction is in the lockout relay, remove and replace lockout relay.

FREON REFRIGERATION ASSEMBLY (FREON PACKAGE) - MAINTENANCE PRACTICES

1. Service Freon Package

CAUTION: THE FOLLOWING SERVICING PROCEDURE APPLIES ONLY WHEN ADDING FREON AND/OR OIL TO AN OPERATIONAL FREON PACKAGE. CHARGING A COMPLETELY VACATED PACKAGE OR A MALFUNCTIONING PACKAGE WHICH HAS BEEN REPAIRED MUST BE ACCOMPLISHED AT OVERHAUL.

A. Equipment Required.

(1) External source of 115/200-volt, 3 phase, 400 cps ac electrical power.

(2) Freon 114 supply bottle containing not more than 10 parts of water per million parts of liquid Freon.

(3) Provisions for heating Freon supply bottle to a maximum of 130 degrees F (54 degrees C).

(4) Flexible hose charging line containing a desiccant dryer to connect the supply bottle to the Freon package. A Hansen quick disconnect fitting (Type 1-K11) is required to connect the charging line to the Freon condenser.

(5) A scale to weigh the Freon supply bottle.

(6) Safety goggles.

WARNING: FREON, WHEN RELEASED TO ATMOSPHERE WILL VAPORIZE RAPIDLY AND IN DOING SO WILL ABSORB HEAT FROM ANY SURFACE IT CONTACTS. ADEQUATE SAFETY GOGGLES MUST BE WORN AT ALL TIMES WHEN SERVICING OR WORKING ON ANY FREON SYSTEM.

B. Check Freon Liquid Level.

NOTE: When operating Freon package to determine Freon quantity, evaporator and condenser inlet air temperatures must be as close to 100 degrees F (37.8 degrees C) as possible. If outside air temperature is low, perform check with airplane in a sheltered area.

(1) Connect and apply external electrical power to airplane (refer to Chapter 24, ELECTRICAL POWER).

(2) Start air-conditioning system and check Freon liquid level as follows:

(a) Place AUTO-OFF-MAN temperature control switch in MAN position. Toggle manual temperature control MAN HOT-MAN COLD switch to MAN HOT position, then toggle toward MAN COLD position until Freon package starts operating. Hold manual temperature control switch in MAN COLD position for a minimum of 80 seconds after Freon package starts operating. (This will place the sequencing device in the full cold position.) When maximum cooling is obtained, hold manual temperature control switch in MAN HOT position for 30 seconds.

(b) After approximately 10 minutes of operation, and with Freon package still operating, observe liquid level indicator on Freon quantity gage. (Gage is visible through small round window in Freon package access door.)

<u>NOTE:</u> Freon quantity readings shall be taken only when Freon package is operating. Gage readings taken when Freon package is shut down are not accurate as liquid Freon may be trapped in various components of the package.

(3) Freon quantity gage indicator shall be within green (OPERATING RANGE) area of dial.

(4) If gage indicator is in red (ADD CHARGE) area of dial, package must be charged with Freon until gage indicator is within green (OPERATING RANGE) area.

<u>CAUTION:</u> IF GAGE INDICATES "DRAIN-RECHARGE" THERE IS A POSSIBILITY THAT TOO MUCH LUBRICATING OIL HAS BEEN LOST WITH THE FREON. THE PACKAGE SHALL BE REPLACED.

(5) When a Freon package charge is low, an evaluation of the rate of Freon loss must be made. If the loss occurred over an extended period (several months) the package can be restored to normal operating capacity by adding Freon. However, if the loss of Freon occurred over a relatively short period, excessive Freon leakage is indicated and the package shall be replaced.

(6) Shut down air conditioning system.

C. Charge Freon Package.

<u>CAUTION:</u> REPEATED ADDITION OF FREON TO A LEAKY PACKAGE MAY LEAD TO A DEFICIENCY OF LUBRICATING OIL AND SUBSEQUENT DAMAGE TO THE FREON COMPRESSOR BEARINGS. IF FREQUENT RECHARGING OF THE FREON PACKAGE IS NECESSARY, ADD 1 OUNCE OF TEXACO CAPELLA AA OIL, FEDERAL SPECIFICATION VV-L-820, WITH EACH FOUR POUNDS OF FREON ADDED TO PACKAGE.

TEMPORARY REVISION NO. 21-41.

Insert facing 21-3-1, Page 202, dated July 25/62.

The instructions in this temporary revision are applicable to airplanes not modified per Hamilton Standard Service Bulletin 21-19. For airplanes that have been modified per Hamilton Standard Service Bulletin 21-19, use the information on 21-3-1, Page 202.

Retain this temporary revision in your manual until applicable airplanes have been modified per noted service bulletin.

Page 202, step (3) should read "Freon quantity gage indicator shall be between red "low-charge" mark and "fill" mark."

Step (4) should read "If gage indicator is below red mark, the package must be charged with Freon until gage indicator is at black mark."

<u>CAUTION:</u> IF GAGE INDICATES "O" OR BELOW, THERE. . . . .

TEMPORARY REVISION NO. 21-42.

Insert facing 21-3-1, Page 203, dated July 25/62.

The information in this temporary revision is applicable to airplanes not modified per Hamilton Standard Service Bulletin 21-19. For airplanes that have been modified per Hamilton Standard Service Bulletin 21-19, use the information on Page 203.

Retain this temporary revision in your manual until applicable airplanes have been modified per noted service bulletin.

Page 203, step (9) should read "Recheck Freon liquid level gage (refer to Check Freon Liquid Level); if gage indication is not up to black "fill" mark, repeat Freon charging procedures per steps (1) through (8)."

(1) Open Hansen fitting at top of Freon condenser and leave open approximately one minute to purge air from Freon package.

NOTE: Step (1) shall be omitted if ambient temperature is below 50 degrees F (10 degrees C).

(2) Pour one (1) ounce of Texaco Capella AA oil, Federal Specification VV-L-820, into Freon charging line upstream of desiccant dryer.

(3) Connect flexible charging line to Freon supply bottle and warm bottle to a maximum of 130 degrees F (54 degrees C).

(4) Invert Freon supply bottle so that liquid Freon will be supplied to Freon package.

(5) Note weight of Freon supply bottle.

(6) Remove cap from quick disconnect fitting on top of Freon condenser and connect flexible charging line to fitting.

(7) Open shutoff valve on Freon supply bottle and observe scale. When scale indicates approximately four pounds of Freon have left supply bottle, close shutoff valve on supply bottle.

NOTE: The Freon flow from the supply bottle will force the oil in the charging line into the Freon pack.

(8) Disconnect charging line from Freon condenser and install cap on condenser quick disconnect fitting.

(9) Recheck Freon liquid level gage (refer to Check Freon Liquid Level). If gage indicator is not within green OPERATING RANGE, repeat Freon charging procedure per steps (1) through (8).

(10) Place AUTO-OFF-MAN temperature control switch in OFF position.

(11) Shut off and remove external electrical power.

(12) Record amount of Freon and oil added to package record tag on bottom of condenser.

2. Removal/Installation Freon Package.

A. Equipment Required.

Lift-truck or table capable of being raised or lowered while supporting Freon package.

NOTE: Supporting surface must be large enough to reach the four support feet on the package, and small enough to allow access to the package for shifting slightly during the raising and lowering process. A Freon package weighs approximately 200 pounds.

B. Preparation.

(1) Open circuit breakers and remove fuses (cabin or flight deck as required) as follows:

(a) FREON SYS CONT

(b) ELEC TEMP CONTROL

(c) FREON COMPR AIR COND HEATER FUSES (NO. 4 NON-ESSENTIAL AC BUS FOR FLIGHT DECK; NO. 2 ESSENTIAL AC BUS FOR CABIN)

(2) Open Freon package access door (cabin or flight compartment as required).

C. Remove Freon Package (see Figure 201).

(1) Release three hose clamps (two on forward end and one on aft end) that secure Freon package ducts to the airplane ducts.

(2) Remove two hose clamps aft of branched condenser cooling duct and remove branched duct.

(3) Disconnect package control power receptacle at forward end of lockout relay. (Tag for installation.)

(4) Remove sequencing device and hold for installation in replacement package (refer to 21-4-1, Maintenance Practices).

<u>NOTE:</u> The flight compartment sequencing device harness has three clamps which secure the harness to the package. Remove clamps from the package and leave them attached to the harness. A replacement package will not have the clamps.

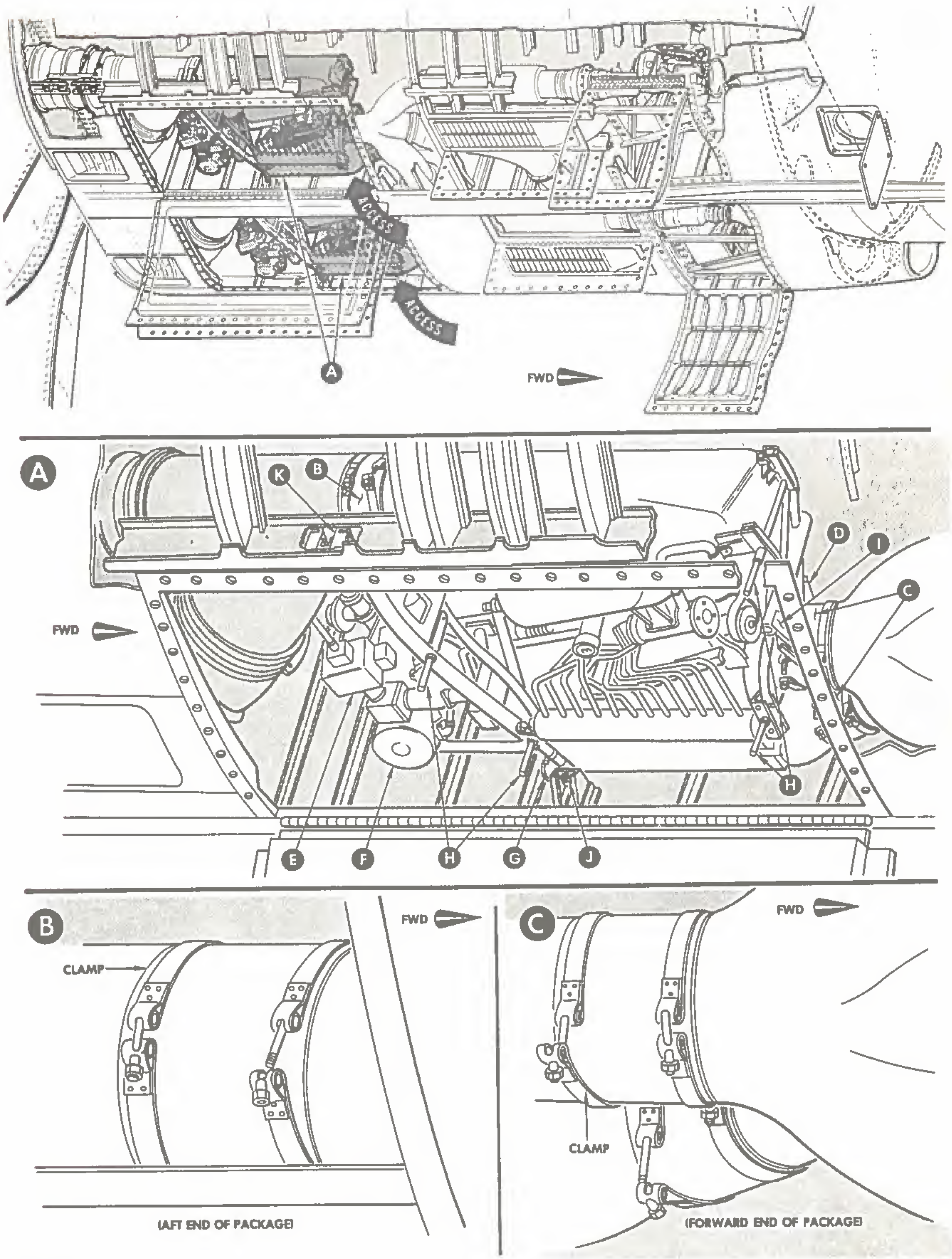
(5) Disconnect power leads from Freon compressor motor. To remove leads, turn terminal caps counterclockwise and slide back to expose terminal connection. (Tag leads for installation.)

(6) Disconnect mounting frame ground strap.

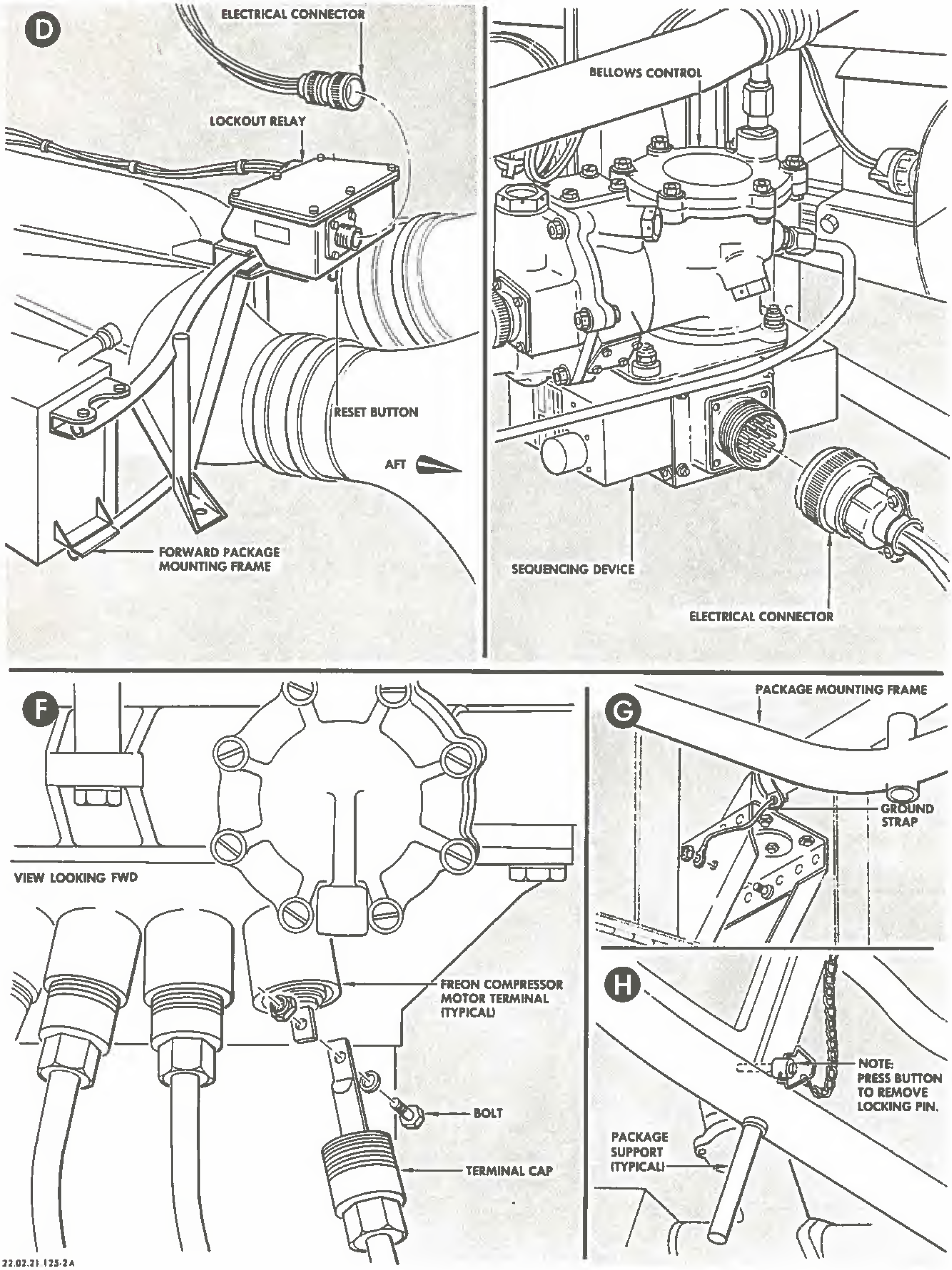
(7) Remove locking pins and extend four support feet below package.

(8) Remove package mounting bolts from forward and inboard mounting points.

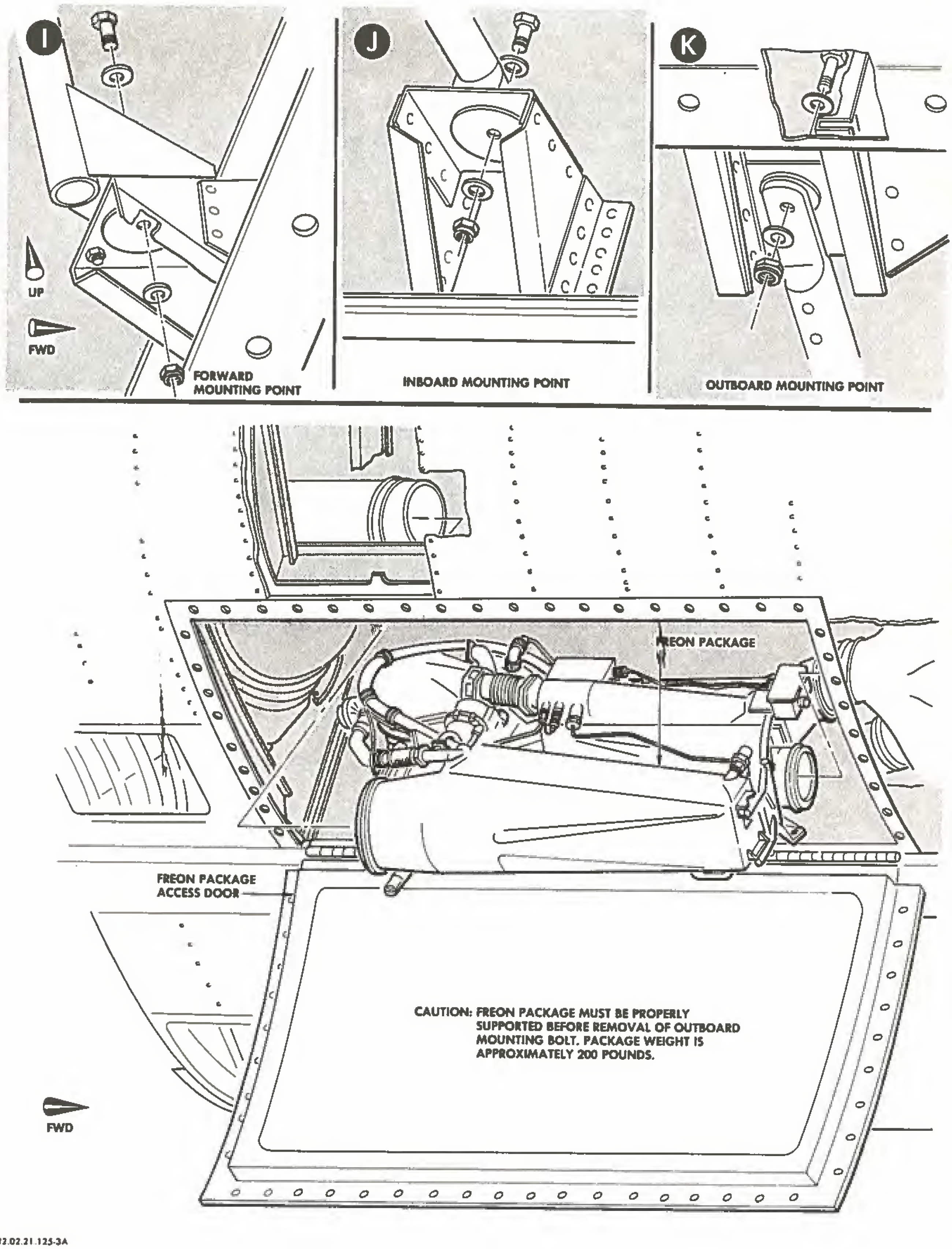
<u>CAUTION:</u> HANDLE FREON PACKAGE BY PACKAGE FRAME OR MAJOR COMPONENTS. DO NOT HANDLE PACKAGE BY FREON LINES OR SMALL CONTROLS. USE A LIFT TRUCK OR SIMILAR DEVICE TO SUPPORT THE FREON PACKAGE BEFORE REMOVING THE OUTBOARD MOUNTING BOLT. PACKAGE WEIGHS APPROXIMATELY 200 POUNDS.



Freon Package Installation
Figure 201 (Sheet 1 of 3)



Freon Package Installation
Figure 201 (Sheet 2 of 3)



Freon Refrigeration Package Installation
Figure 201 (Sheet 3 of 3)

(9) With Freon package properly supported, remove outboard mounting bolt.

(10) Remove Freon package by lowering outboard edge and then sliding package outboard to clear forward and inboard mounting points. Lower package to clear airplane.

D. Install Freon Package (see Figure 201).

(1) Refer to paragraphs A and B above.

(2) Tie power leads and electrical connectors clear of area occupied by Freon package.

(3) Using a lift truck or similar device, raise package to within a few inches of its mounted position. Then raise the inboard edge to position the package mounting frame above the support bracket in the airplane. Slide the package inboard with the forward and inboard package mounting points above the support brackets. Raise the outboard mounting point into position below the airplane support bracket. Slight shifting may be necessary to install the three mounting bolts.

NOTE: The Freon package mounting frame goes above the airplane support brackets at the forward and inboard mounting points. The Freon package mounting frame goes below the airplane support bracket at the outboard mounting point.

(4) Install three mounting bolts, washers and nuts to secure package in airplane.

(5) Remove the lift truck or supporting device, and raise the four package support feet.

(6) Install branched condenser cooling duct aft of package.

(7) Position hoses and install three duct connecting clamps. (Two on forward end and one on aft end of package.)

(8) Connect power leads to the Freon compressor motor. Slide terminal cap back on power lead and connect lug to motor terminal with bolt and nut. Then slide terminal cap up to motor and screw into place. Tighten terminal cap to a torque of 100 to 150 inch pounds and install safety wire.

CAUTION: RECHECK LEADS TO INSURE CONNECTION TO PROPER TERMINAL.

(9) Connect electrical connector to sequencing device near aft end of package.

NOTE: The control harness to the flight compartment (LH side) Freon package uses three clamps to secure the harness to the Freon package. When installing a flight compartment package, install the three clamps to prevent the harness from hanging down and rubbing on the access door.

(10) Connect and safety wire package control harness to the forward end of the lockout relay.

(11) Attach ground strap from the airplane to the package mounting frame.

(12) Install three FREON COMP & AIR COND HEATER fuses in the ac power distribution panel (No. 2 ESS AC BUS) (below flight engineer's control panel).

(13) Remove warning tags and close the FREON SYS CONT and the ELEC TEMP CONTROL circuit breakers.

(14) Check operation of the air conditioning system (refer to 21-0 Maintenance Practices).

(15) Recheck security of duct clamps and electrical connectors on the Freon package.

(16) Close the Freon package access door.

3. Inspection/Check

A. Maintenance Check.

(1) Examine the Freon package frame support tubing and welds.

(a) The frames shall be free from visible cracks.

(b) The mounting point locknuts shall be tight.

(c) The nuts and bolts that connect the components of the Freon package shall be secure.

(2) Examine mounting brackets on Freon package that connect to the airplane. Each mounting bracket shall be securely attached to its respective member and it shall be free from cracks.

(3) Examine all Janitrol and Marman clamps. They shall be tight and free of visible cracks.

(4) Examine all electrical connectors. They shall be secured to their respective socket, and the wiring shall be free of fraying, excessive vibration or wear.

(5) If Freon package is removed from airplane, examine all cabin air and ram air passages of the vaper cycle system for cracks, leaks or for foreign material which tends to restrict air flow.

(6) Examine rubber blowout plug on condenser relief valve; plug shall be in place.

4. Cleaning/Painting

A. Cleaning the Freon Package.

(1) Clean exterior surfaces with solvent, Specification AMS 3160A to remove any dirt, grease or oil deposits (as required).

WARNING: EXERCISE CARE TO INSURE THAT NONE OF THIS SOLVENT ENTERS THE CABIN AIR PORTS OF THE PACKAGE. APPLY SOLVENT WITH SOFT CLOTH MOISTENED NOT SATURATED WITH SOLVENT.

(2) Clean the following by flushing with a solution of soap and clean water. The soap used shall be Kelite No. 14, (or equivalent) manufactured by the Kelite Corporation.

(a) All cabin air passages of the Freon package.

(b) The ram air side of the condenser core.

(c) The cabin air side of the evaporator core.

(d) The water separator mesh. (See Figure 202.)

(3) Rinse all soap with clean water.

(4) Dry all cores and passages completely by passing dry air through them.

B. Painting the Freon Package.

(1) Touch up worn or damaged painted surfaces as follows:

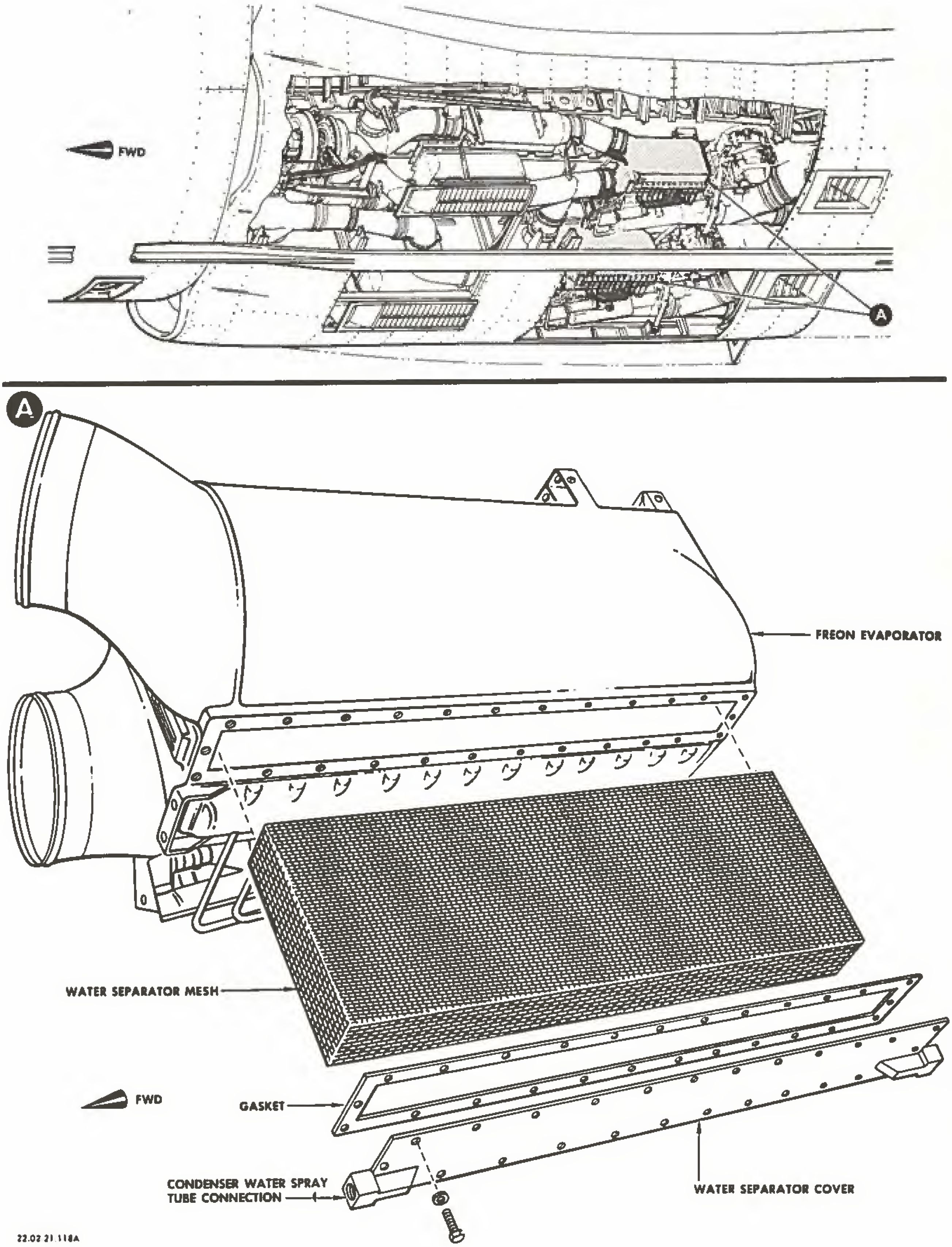
(a) Remova all corrosion with steel wool or crocus cloth prior to the application of the primer coat.

(b) Apply a primer coat of zinc chromate ASM 3110C to obtain a semi-transparent greenish-yellow surface.

(c) Allow primer to air-dry 30 minutes at room temperature.

(d) Apply two topcoats of glyceryl phthalate black enamel, AMS 3120B.

(e) Allow each coat of enamel to air-dry 4 hours at room temperature before applying the second coat or before handling.



Removal of Water Separator From Freon Evaporator
Figure 202

5. Approved Repairs

A. Remove all dents or scratches in the air passages of the Freon package.

(1) Remove dents, accessible from the inside of the ducts, with a raw-hide hammer.

(2) Polish out scratches with crocus cloth.

(3) Remove burrs from the Marman and Janitrol clamp flanges with fine crocus cloth.

B. During line maintenance, the following components may be replaced in the Freon package without disturbing the Freon loop. The removal and installation procedures are included in the maintenance practices of the individual component.

(1) Sequencing Device

(2) Thermal Resistor and Connector

(3) Condenser Temperature Control

(4) Back Pressure Control

(5) Freon Lockout Relay

C. When repairs require that the Freon loop be opened, the Freon package should be replaced because of the time required for draining, purging and recharging the Freon system.

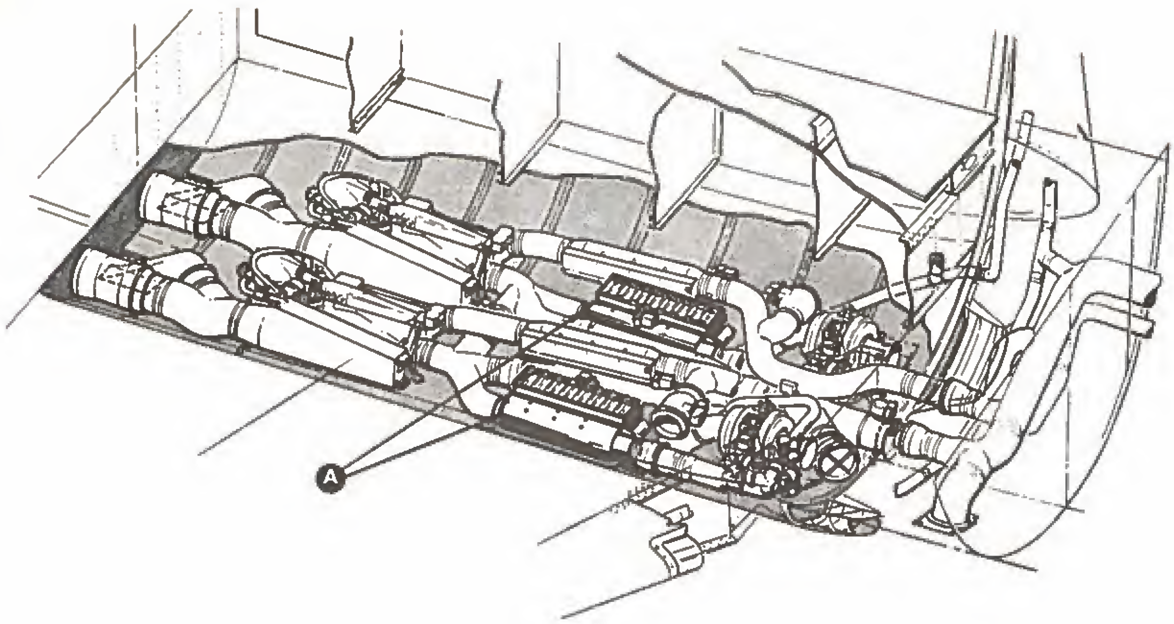
AIR-TO-AIR HEAT EXCHANGER - DESCRIPTION AND OPERATION

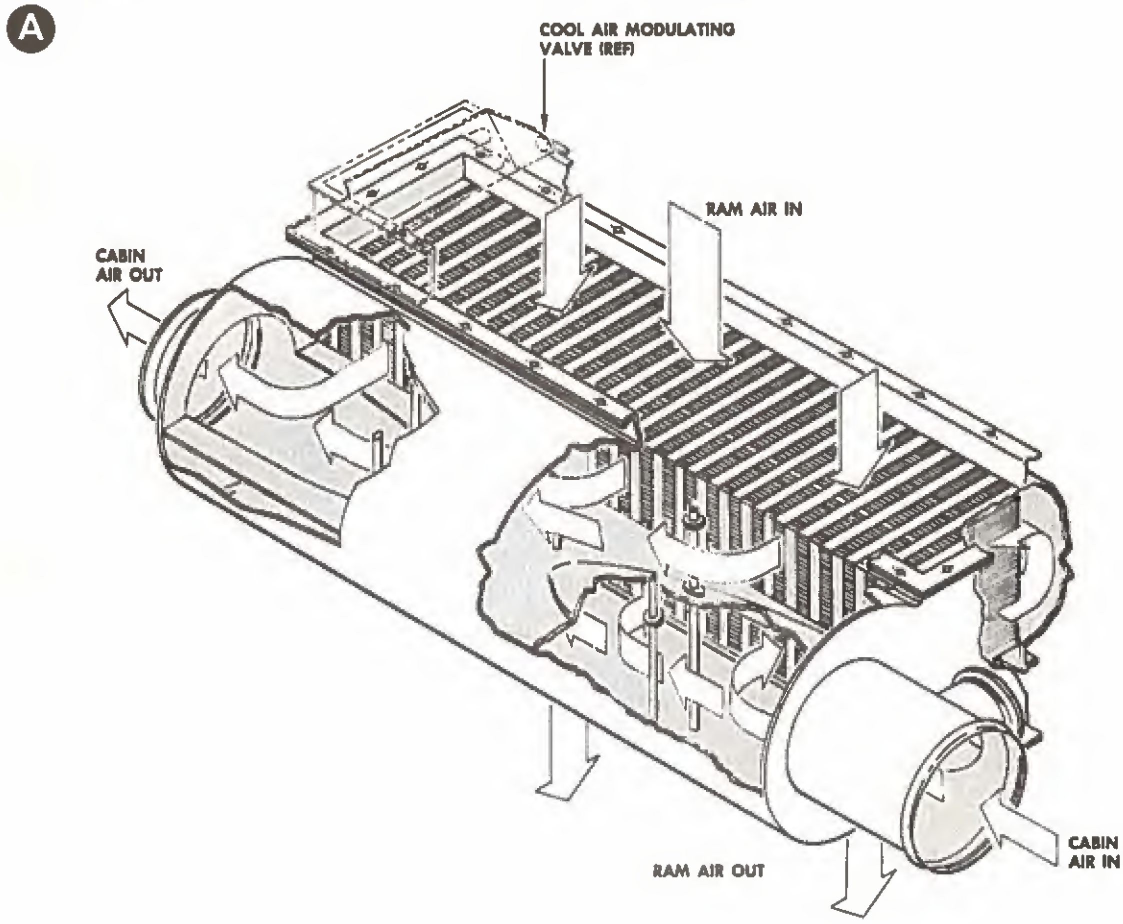
1. Description

The heat exchanger, shown on Figure 1, is a rectangular box with a cylindrical duct on one side. Internally it contains a heat exchanger core of plate and fin design with a system of passageways connecting into the cylindrical duct on each side of a baffle. A second set of passageways connect the rectangular ram air inlet to the ram air outlet. The cylindrical duct contains a diagonal baffle secured by six rods extending through the cylinder. The heat exchanger cooling air modulating valve is connected to the ram air inlet to the heat exchanger. The ram air exit end of the heat exchanger connects to an overboard exit duct.

2. Operation

Pressurized air from the turbocompressor flows in the inlet end of the cylindrical duct to the baffle which directs the air to the exchanger core. The air flows through the first level of the exchanger core then is directed back through the second level and into the cylindrical duct. The ram air flows into the top of the exchanger through the exchanger core and to the ram air discharge on the lower side of the exchanger. Heat is transferred from the pressurized air to the ram air by conductance through the plates and fins of the core. The plates and fins are arranged to provide maximum conducting surfaces exposed to both air passageways.





22.30.21.063

Heat Exchanger
Figure 1

AIR-TO-AIR HEAT EXCHANGER - MAINTENANCE PRACTICES

1. Removal/Installation - Air-to-Air Heat Exchanger (See Figure 201.)

   A. Equipment Required - None.

   B. Preparation.

      (1) Open FREON SYS CONT and the ELEC TEMP CONTROL circuit breakers (cabin or flight compartment).

      (2) Open heat exchanger access doors (cabin and flight compartment).

   C. Remove Cabin Air-to-Air Heat Exchanger.

      (1) Remove nuts, bolts, and washers from connecting flanges on both ends of duct section which bends approximately 45 degrees. (Bag and tag for installation.)

      (2) Remove cabin electric heater (refer to 21-3-13, Maintenance Practices).

      (3) Release clamp to disconnect emergency pressurization duct (small duct perpendicular to exchanger inlet duct) at forward end of heat exchanger.

      (4) Remove hose clamps from connecting ducts on forward and aft ends of heat exchanger.

      (5) Disconnect electrical connector from heat exchanger cooling air modulation valve actuator. (Tag for installation.)

      (6) Remove louver from under heat exchanger by removing screws on aircraft exterior. (Bag and tag for installation.)

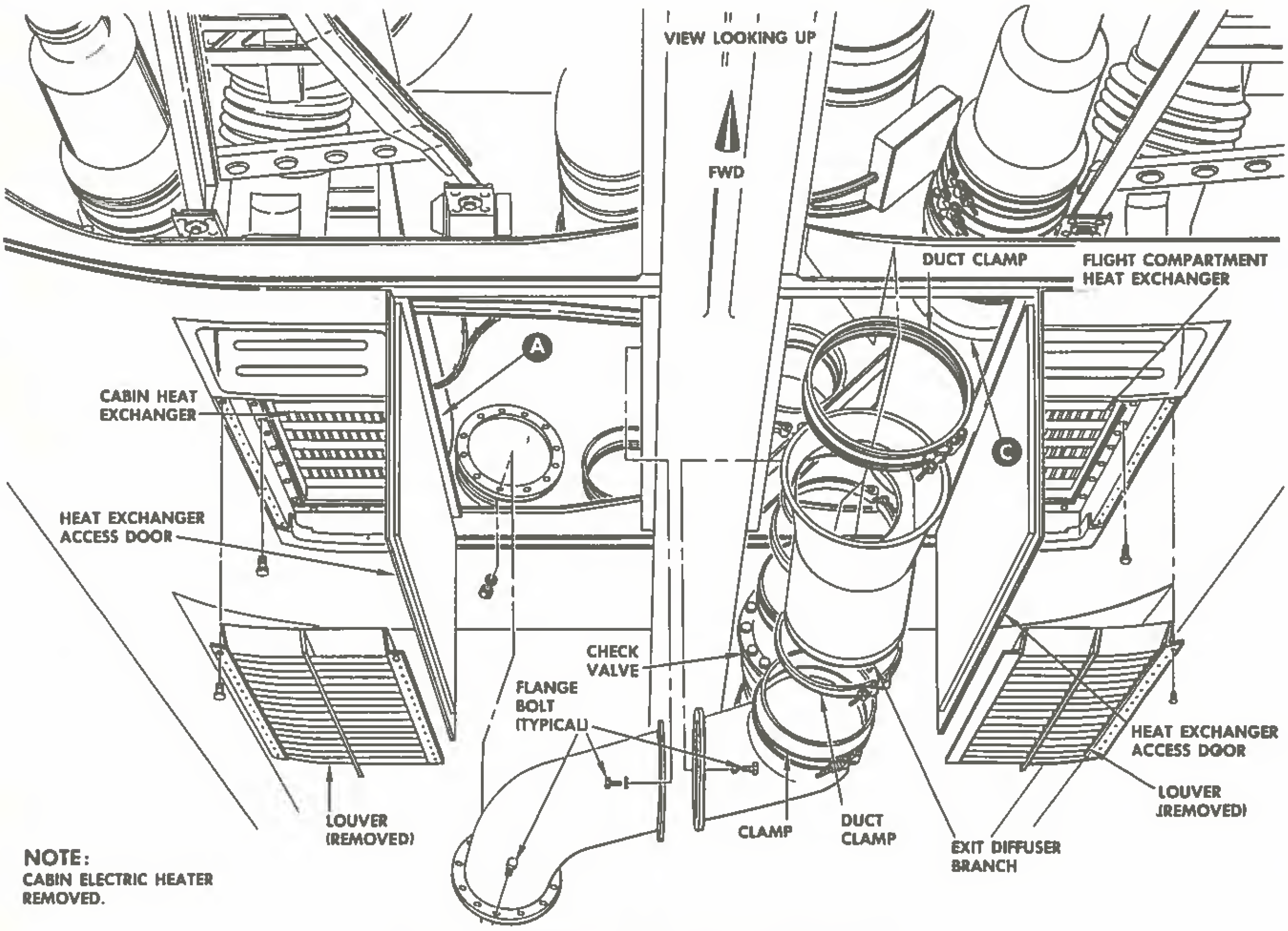
      (7) Remove mounting bolts from bottom of heat exchanger. (Bag and tag for installation.)

      (8) Remove heat exchanger with attached modulating valve through the heat exchanger access door.

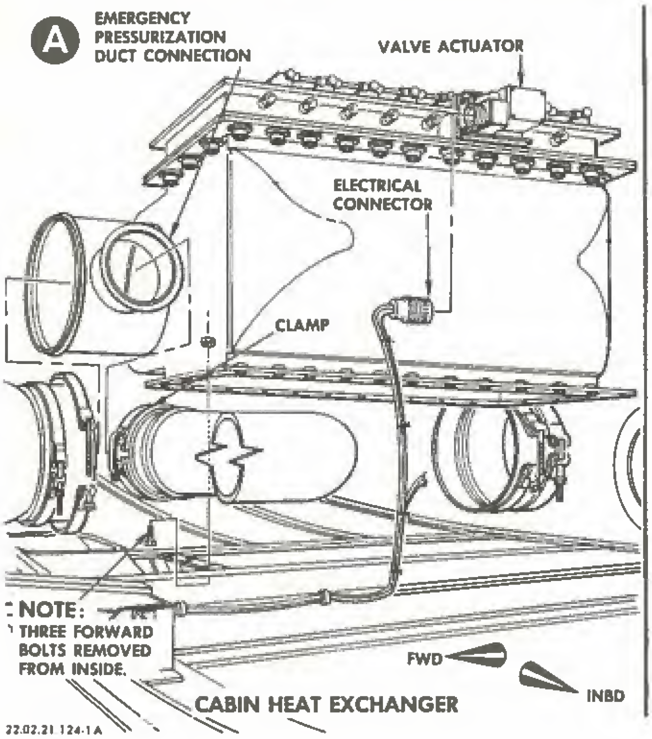
      (9) Separate modulating valve from heat exchanger by removing retaining bolts and washers on top of heat exchanger. (Bag and tag for installation.)

   D. Install Cabin Air-to-Air Heat Exchanger.

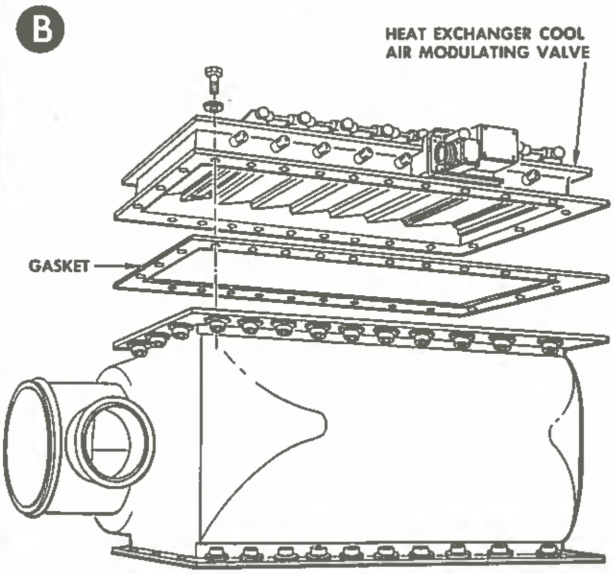
      (1) Position heat exchanger cooling air modulating valve and gasket on top of heat exchanger; install valve with valve actuator on inboard side.



AFT END OF AIR CONDITIONING COMPARTMENT

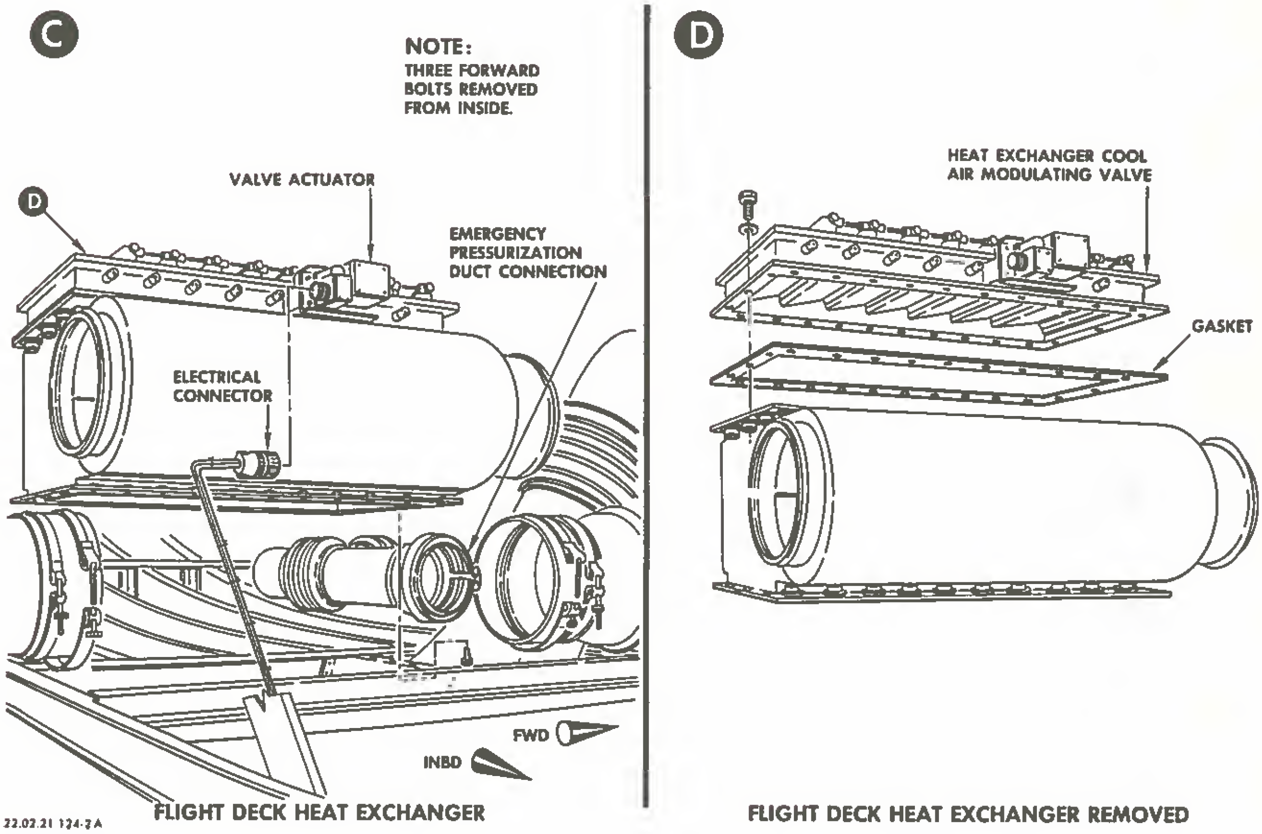


CABIN HEAT EXCHANGER



CABIN HEAT EXCHANGER REMOVED

Heat Exchanger Installation
Figure 201 (Sheet 1 of 2)



Heat Exchanger Installation
Figure 201 (Sheet 2 of 2)

NOTE: The smaller emergency pressurization duct connection is on the forward end of the heat exchanger. The modulating valve actuator is always in the inboard side. The cabin and flight deck heat exchangers can be interchanged if the cooling air modulating valve is turned around.

(2) Install retaining bolts and washers to secure modulating valve to heat exchanger.

(3) Insert assembled heat exchanger and modulating valve through the right hand heat exchanger access door. Position on mounting base, and install heat exchanger retaining bolts from the bottom and secure.

(4) Position louver under heat exchanger with vanes pointing down and aft. Install retaining screws.

(5) Connect electrical connector to modulating valve actuator; secure connector with safety wire.

(6) Install connecting hose and clamps on forward and aft end of heat exchanger.

(7) Install connecting hose and clamp on emergency pressurization duct connection. Torque to 100-120 inch pounds. (Small duct perpendicular to exchanger inlet duct.)

(8) Install cabin electric heater (refer to 21-3-13, Maintenance Practices).

(9) With new gasket in place, position duct section which bends approximately 45 degrees, and install bolts, washers, and nuts in connecting flanges on both ends.

(10) Close heat exchanger access door.

(11) Remove warning tags and close cabin FREON SYS CONT and cabin ELEC TEMP CONTROL circuit breakers.

(12) Perform operational check of system (refer to 21-0, Maintenance Practices).

E. Remove Flight Compartment Air-To-Air Heat Exchanger.

(1) Reaching through the right heat exchanger access door, remove the nuts, bolts, and washers from connecting flange on the forward end of the duct (bends approximately 45 degrees). (Bag and tag hardware for installation.)

(2) Reaching through the left heat exchanger access door, remove the branched duct section by releasing one clamp on forward end and two clamps on aft end. (Tag for installation.)

(3) Remove duct section which passes through the centerline bulkhead by removing bolts from mounting plate on left hand side of bulkhead. (Bag and tag for installation.)

(4) Remove the short straight duct section which runs aft from the branched duct by releasing the hose clamp aft of the check valve, and the mounting clamp forward of the check valve. (Remove the assembled duct and check valve to eliminate having to remove the flange bolts which connect the duct to the check valve.) (Tag for installation.)

(5) Disconnect emergency pressurization duct at forward end of heat exchanger by releasing hose clamp. (Small duct perpendicular to exchanger inlet duct.)

(6) Remove hose clamps from connecting ducts on forward and aft ends of heat exchanger. (Tag for installation.)

(7) Disconnect electrical connector from heat exchanger cooling air modulation valve actuator. (Cap connector and tag for installation.)

(8) Remove louver from under heat exchanger by removing screws on airplane exterior. (Bag and tag for installation.)

(9) Remove mounting bolts from bottom of heat exchanger. (Bag and tag for installation.)

(10) Remove heat exchanger with attached modulating valve through the heat exchanger access door.

(11) Separate the modulating valve from the heat exchanger by removing retaining bolts and washers on top of exchanger. (Bag and tag for installation.)

F. Installation of Flight Deck Air-to-Air Heat Exchanger.

(1) Position heat exchanger cooling air modulating valve and gasket on top of heat exchanger with valve actuator on inboard side.

<u>NOTE:</u> The smaller emergency pressurization duct connection is on the forward end of the heat exchanger. The modulating valve actuator is always on the inboard side. The flight deck and cabin heat exchangers can be interchanged if the cooling air modulating valve is turned around.

(2) Install retaining bolts and washers to secure modulating valve to heat exchanger.

(3) Insert assembled heat exchanger and modulating valve through the left hand heat exchanger access door. Position on mounting base, and install heat exchanger retaining bolts from the bottom, and secure.

(4) Position louver under heat exchanger with vanes pointing down and aft. Install retaining screws.

(5) Connect electrical connector to modulating valve actuator. Safety connector.

(6) Install connecting hose and clamps on forward and aft ends of heat exchanger.

(7) Install connecting hose and clamp on emergency pressurization duct connection. (Small duct perpendicular to exchanger inlet duct.)

(8) Position short straight duct section (with check valve) and secure to mounting bracket with clamp just ahead of check valve. Install hose and clamp aft of check valve.

(9) Position short duct section (with mounting plate) that passes through centerline bulkhead. Install mounting plate retaining bolts. (Left hand heat exchanger access door.)

(10) Position branched duct section to connect recirculation fan outlet duct to the straight duct section running aft, and to the curved duct section which passes through the centerline bulkhead. Install hose and clamps for the three connections.

(11) Reaching through the right hand heat exchanger access door, position new gasket, install bolts, washers, and nuts to connect duct with a 45 degree bend to the duct which passes through the centerline bulkhead.

(12) Close heat exchanger access doors.

(13) Remove warning tags and close the flight deck FREON SYS CONT and flight deck ELEC TEMP CONTROL circuit breakers.

(14) Perform operational check of system (refer to 21-0, Maintenance Practices).

2. Inspection/Check

A. Examine exterior surfaces. They shall be without the damage, wear, or corrosion described.

(1) Examine all flanges for cracks, scratches, or dents that might cause connection leakage.

(2) Check elastic stop nuts on the ram air flanges for damaged or deteriorated nylon inserts.

(3) Examine all mounting brackets for damage that may effect the mounting angle.

(4) Examine painted surfaces for damage that exposes metal and check these areas for corrosion.

(5) Check all areas, especially seams, for cracks, dents, or cuts.

3. Cleaning/Painting

A. Clean the Heat Exchanger.

(1) Clean exterior (painted) surfaces with solvent, Specification AMS 3160A to remove any dirt, grease or oil deposits (as required).

WARNING: EXERCISE CARE TO INSURE THAT NONE OF THIS SOLVENT ENTERS THE HEAT EXCHANGER CORE. APPLY SOLVENT WITH SOFT LINT-LESS CLOTH OR SOFT BRUSH.

(2) Clean the heat exchanger core by immersion in solution of 4-6 oz. Kelite per gallon of water at 160 to 180 degrees F (71 to 82 degrees C) for 3-10 minutes and rinse with clean water at 140 degrees F (60 degrees C). Kelite is obtainable from the Kelite Corp., Los Angeles, California.

(3) Dry the core completely, passing dry air through the passages.

NOTE: Elevated temperatures up to 250 degrees F (121 degrees C) may be used for drying.

RECIRCULATION FAN - DESCRIPTION AND OPERATION

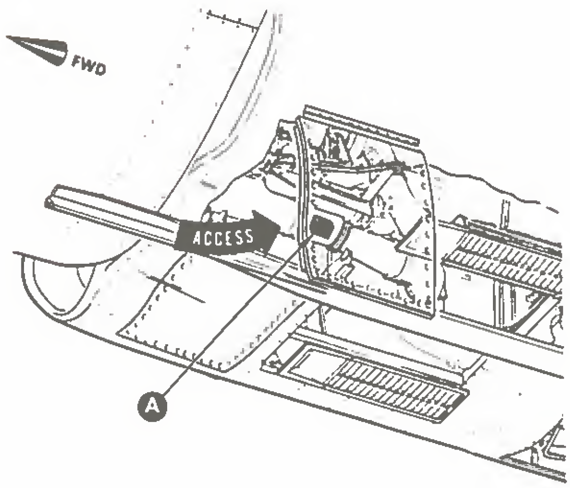
1. Description

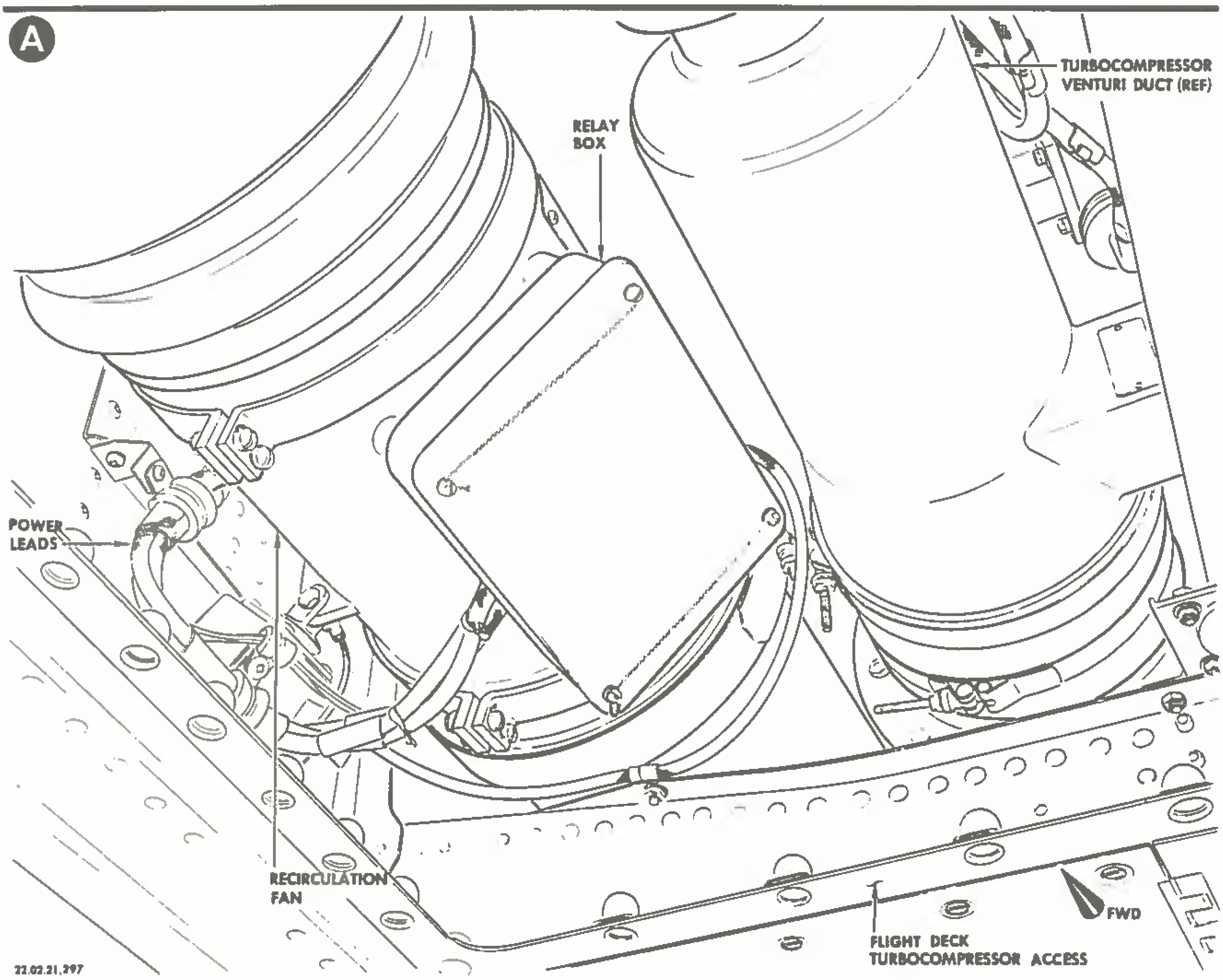
The recirculation fan, shown on Figure 1, is an axial flow type fan with impellers on both inlet and outlet. The fan is powered by an induction motor containing a normally-open self-resetting thermal protective switch connected to a lockout relay on the fan housing. The fan motor contains a single-phase current protection circuit which protects the fan motor from damage due to a "failed" current limiter. This circuit is also connected to the lockout relay. Power is supplied through a fan motor relay which is connected to 28-volt dc power through the contacts of the RECIRCULATING BLOWER ON-OFF switch. The dc power is grounded through contacts of the lockout relay.

2. Operation

The recirculation fan is used primarily during ground operation to recirculate cabin air on airplanes N801TW and N812TW through N830TW, or to provide fresh air to the cabin compartments on airplanes N802TW through N811TW. The fan can also be used during flight to recirculate cabin air in the event one turbocompressor becomes inoperative. Operation of the fan is controlled by the RECIRCULATING BLOWER ON-OFF switch and the lockout relay. When the switch is in the ON position 28-volt dc power is supplied to energize the fan motor relay. The closed contacts of the relay provide 115/200 volt, three phase, ac power to the "Y" connected windings. The energized solenoid of the fan motor relay is grounded through the lockout relay. If the motor overheats during fan operation the thermal switch closes a circuit that energized the lockout relay thus de-energizing the motor relay by interrupting ground. The thermal switch resets automatically when the fan motor temperature returns to normal.

If one current limiter in the 115/200-volt ac three-phase line opens, an additional circuit protects the motor from burning out. In the event that one leg of the three-phase voltage is lost, current flows through the voltage limiting resistor and through a rectifying diode. When this voltage is above 28 volts the four layer diode acts as a switch and permits this voltage to pass through a second rectifying diode. This voltage then energizes the lockout relay in the same manner as the thermal overload switch. The fan is then inoperative until the lockout relay has been manually reset by a push button on the relay box.





Recirculation Fan
Figure 1

RECIRCULATION FAN - MAINTENANCE PRACTICES

1. Removal/Installation Recirculation Fan (see Figure 201)

   A. Equipment Required - None.

   B. Preparation.

      (1) Open RECIRC FAN CONTROL circuit breaker.

      (2) Remove three RECIRC FAN fuses from the No. 3 ac ESS BUS power distribution panel located below flight engineer's control panel.

      WARNING: DO NOT OPEN AC POWER DISTRIBUTION PANEL WHEN BATTERY IS ON, ENGINES ARE RUNNING, OR WHEN EXTERNAL POWER IS CONNECTED TO AIRPLANE.

      (3) Open flight compartment (LH side) turbocompressor access door.

   C. Remove Recirculation Fan.

      (1) Remove cover from fan relay box. (Relay box is attached to fan which is mounted in duct running next to the centerline bulkhead.)

      (2) Disconnect motor power leads from power terminal. (Power leads are the large wires.)

      NOTE: Power leads are tagged "T1", "T2" and "T3" to insure proper connection to their respective terminals.

      (3) Disconnect three leads from relay terminals A, B, and C. (Tag leads to insure proper connection upon installation.)

      (4) Slide disconnected leads through grommet in relay box.

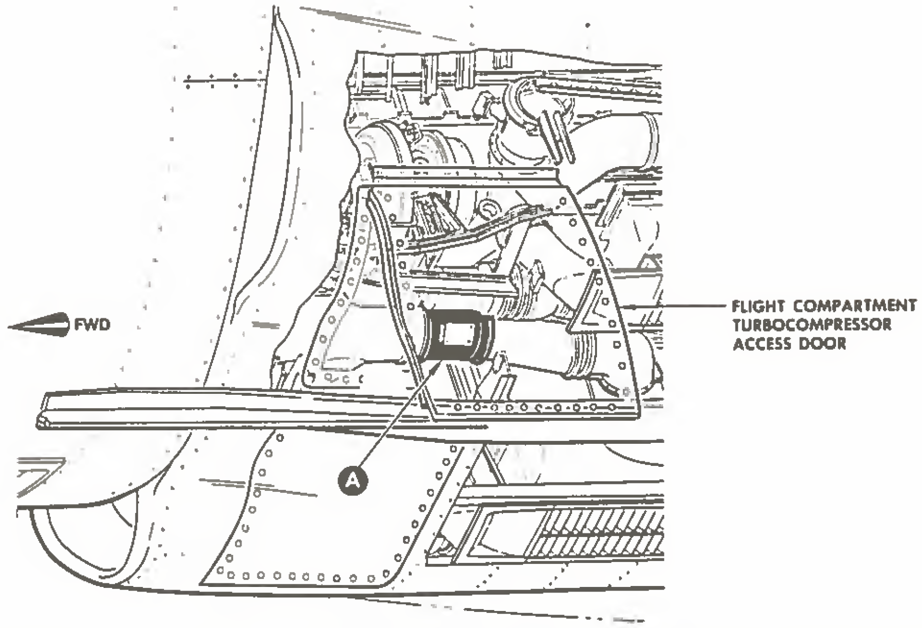
      (5) Replace cover on relay box.

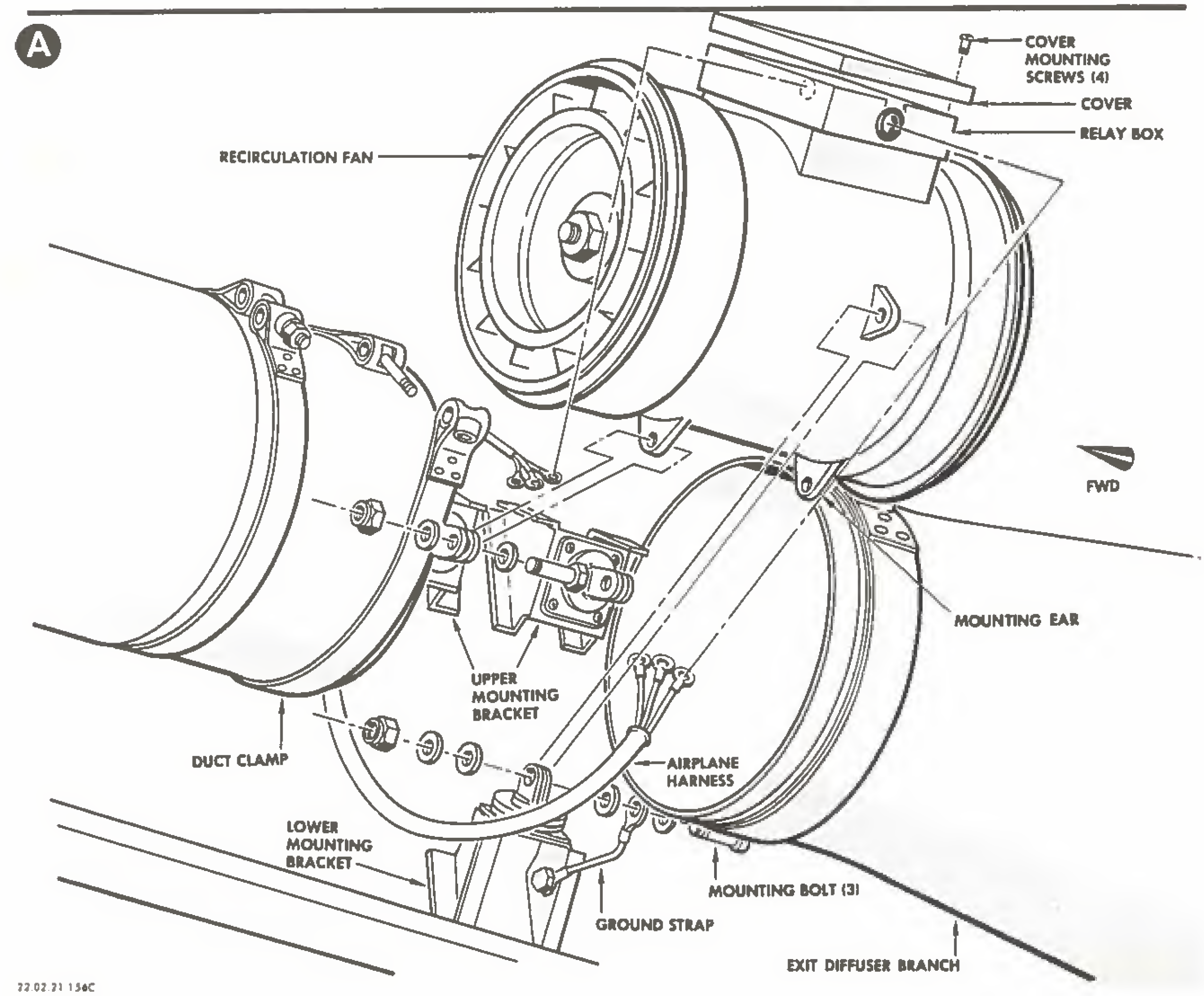
      (6) Release duct clamps on each end of recirculation fan. (Tag for installation.)

      (7) Remove nuts from three mounting bracket attach bolts securing fan to centerline bulkhead. (Leave bolts in place.)

      (8) Remove lower mounting bolt and disconnect ground strap.

      (9) While supporting fan, remove remaining two mounting bolts and remove fan.





Recirculation Fan Installation
Figure 201

D. Install Recirculation Fan.

(1) Position fan against centerline bulkhead with three mounting ears on fan in line with mounting brackets on bulkhead; install bolts loosely in two upper brackets but do not secure at this time.

(2) Place third mounting bolt through ground strap and fan lower mounting ear; install bolt in fan lower mounting bracket.

(3) Install and tighten nuts on three mounting bolts.

(4) Position duct hose and install duct clamps on each end of fan.

(5) Remove cover from relay box.

(6) Slide power leads (large wires) and relay control leads through grommets in side of relay box.

(7) Connect power leads to proper terminals. (Carefully check identification tags on the power leads.)

(8) Connect control leads to relay terminals A, B, and C. (Carefully check identification tags on leads.)

(9) Install cover on relay box.

(10) Install three RECIRC FAN fuses in No. 3 ac ESS BUS power distribution panel.

CAUTION: DO NOT OPEN THE AC POWER DISTRIBUTION PANEL WITH THE BATTERY ON, THE ENGINES RUNNING, OR WITH EXTERNAL POWER CONNECTED TO THE AIRPLANE.

(11) Close RECIRC FAN CONTROL circuit breaker.

(12) Operate recirculation fan for at least 15 minutes. There shall be no indication of malfunction and no sign of overheating.

NOTE: If direction of rotation is wrong, recheck power leads for proper connection.

(13) Close turbocompressor access door.

2. Inspection/Check

A. Examine Fan Exterior Details.

(1) Check mounting beads; they shall be free from cracks, scratches or other damage that might impair effective sealing.

(2) Examine mounting ears; they shall be free from damage or wear.

(3) The duct housing shall be smooth and free from dents or damage.

(4) Any exposed metal shall be free from corrosion.

(5) Examine relay box for secure attachment to fan housing.

(6) Check the relay box exterior, the walls shall be smooth and free from dents, nicks or other damage.

Cleaning/Painting

A. Clean the Fan Exterior.

(1) Remove grease and oil deposits using a soft lintless cloth moistened with solvent, Specification AMS 3160A.

WARNING: DO NOT IMMERSE UNIT IN SOLVENT.

(2) Allow cleaned surface to dry thoroughly. Use filtered compressed air, as required, for drying.

(3) Remove any corrosion with fine crocus cloth.

B. Tough-up paint damage when extent of damage does not exceed 5 percent of the total painted surface.

(1) Apply one coat of zinc chromate primer, Specification AMS 3110C and allow to dry thoroughly (30 minutes min.).

(2) Apply two coats of glyceryl phthalate black enamel, Specification AMS 3120B and allow each coat to dry 4 hours.

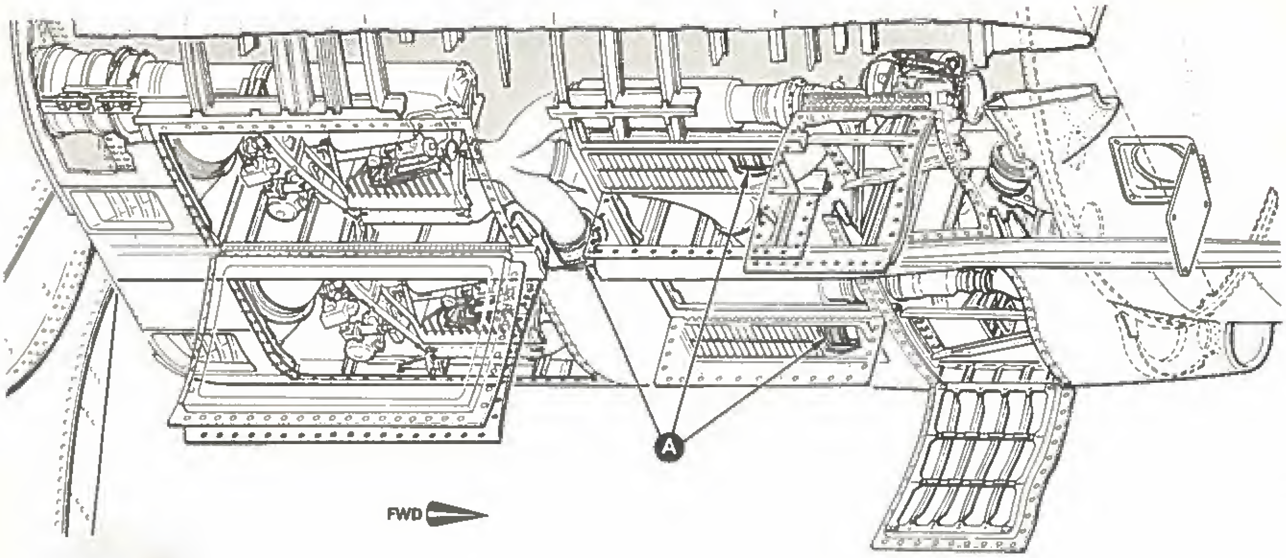
CONDITIONED AIR EMERGENCY AND CROSSOVER SHUTOFF VALVES - DESCRIPTION AND OPERATION

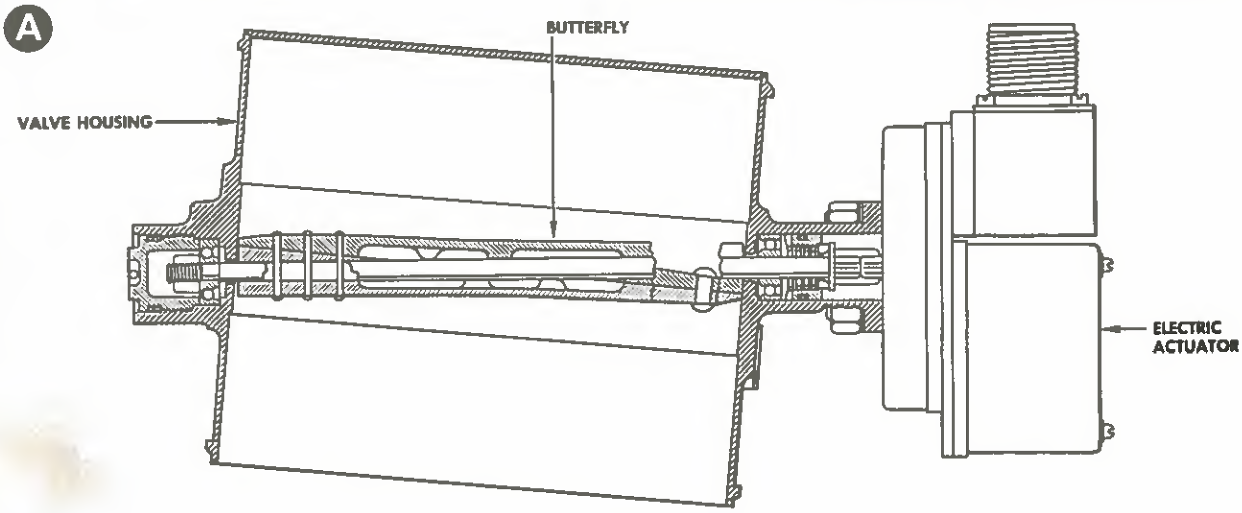
1. Description

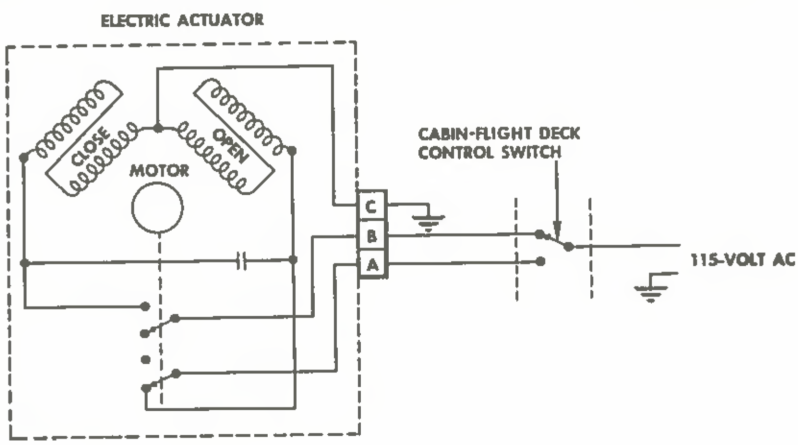
The conditioned air emergency and crossover shutoff valves, shown on Figure 1, are six inch electrically actuated butterfly valves. The electric actuators contain a capacitor, a motor, and open and closed limit switches. Airplane wiring connects the actuator to the FREON COMPRESSOR FLT DECK OFF-BOTH ON-CABIN OFF control switch on the flight engineer's control panel.

2. Operation

The conditioned air emergency shutoff valve remains open during normal operation of the air conditioning and pressurization system. If it becomes necessary to shut down one of the Freon packages, the corresponding conditioned air emergency shutoff valve is automatically closed. Since the conditioned air emergency shutoff valve is electrically interconnected with the Freon compressor and crossover shutoff valve, the two valves will route the output of both turbocompressor packages (or emergency pressure sources) through the single operating Freon package. This is accomplished by opening the crossover shutoff valve when either the cabin or the flight compartment conditioned air emergency shutoff valve is closed. All of these functions are controlled by a single three-position switch labeled FLT DECK OFF-BOTH ON-CABIN OFF. When the switch is in the BOTH ON position, both Freon packages will operate, both conditioned air emergency shutoff valves will be open, and the crossover shutoff valve will be closed. Moving the switch to the CABIN OFF position will shut down the cabin Freon package, close the cabin conditioned air emergency shutoff valve, and open the crossover shutoff valve. This will route the output of both turbocompressors through the flight compartment Freon package for cooling. In a similar manner, switching to the FLT DECK OFF position will route all pressurized air through the cabin Freon package.







22.30.21.0138

Conditioned Air Emergency and Crossover
Shutoff Valves
Figure 1

CONDITIONED AIR EMERGENCY SHUTOFF VALVE - MAINTENANCE PRACTICES

1. Removal/Installation Conditioned Air Emergency Shutoff Valve

   A. Equipment Required - None.

   B. Preparation.

      (1) Open CAB FLT DECK AIR SHUTOFF circuit breaker. Place warning tag on open circuit breaker.

   C. Remove Cabin Conditioned Air Emergency Shutoff Valve.

      (1) Open the cabin heat exchanger access door (right side).

      (2) Disconnect electrical connector from the conditioned air emergency shutoff valve. The valve is located forward of the electric heater, (Cap connector and receptacle. Tag harness for installation.)

      (3) Remove forward and aft hose clamps to release valve. (Tag for installation.)

      (4) Remove valve through the heat exchanger access door.

   D. Install Cabin Conditioned Air Emergency Shutoff Valve.

      (1) Position shutoff valve between duct openings forward of the electric heater. (The electric actuator shall be at the 2 o'clock position when viewed from the aft end.)

      (2) Position hoses and install hose clamps to secure valve in position.

      (3) Connect electrical connector to valve actuator.

      (4) Close heat exchanger access door.

      (5) Remove warning tag and close CAB FLT DECK AIR SHUTOFF circuit breaker.

      (6) Perform operational check of system (refer to 21-0, Maintenance Practices).

   E. Remove Flight Compartment Conditioned Air Emergency Shutoff Valve.

      (1) Remove the flight compartment (left side) turbocompressor package (refer to 21-1-0, Maintenance Practices).

      (2) Disconnect electrical connector from the conditioned air emergency shutoff valve. Looking aft from the turbocompressor access door, the valve is located near the top of the compartment on outboard edge, and just forward of the electric heater. (Cap connector and receptacle. Tag harness for installation.)

(3) Remove forward and aft hose clamps to release valve. (Tag for installation.)

(4) Move valve outboard and then forward for removal through the turbocompressor access door.

F. Install Flight Compartment Conditioned Air Emergency Shutoff Valve.

NOTE: Flight compartment turbocompressor package must be removed for installation of the flight compartment conditioned air emergency shutoff valve (refer to 21-1-0, Maintenance Practices).

(1) Move valve outboard from the turbocompressor door and then aft through the space outboard of the air conditioning components to reach the mounting position. Position valve between duct openings forward of the electric heater with the direction of flow arrow pointing aft. The electric actuator shall be at the 5 o'clock position when viewed from the aft end.

(2) Position hoses and install forward and aft hose clamps to secure valve in position.

(3) Connect electrical connector to the valve actuator.

(4) Remove warning tag and close the CAB FLT DECK AIR SHUTOFF circuit breaker.

NOTE: An operational check of the valve may be performed prior to installing the turbocompressor package. Check operation by using the recirculation fan and the FLT DECK OFF-BOTH ON-CABIN OFF switch (refer to 21-0, Maintenance Practices).

(5) Install the flight compartment turbocompressor package (refer to 21-1-0, Maintenance Practices).

(6) Perform operational check of system if not done prior to installation of turbocompressor package.

2. Inspection/Check

A. Examine the valve exterior. Parts shall be free from the damage described.

(1) Check the condition of actuator receptacle.

(a) Look for damaged or worn threads.

(b) Check pins for looseness or bending.

(2) Examine inlet and outlet connecting beads for cracks, scratches, grooves or other damage that might cause leakage.

(3) Check the actuator mounting bolts and shaft end plug for tightness.

(4) Examine all surfaces for damage or wear.

(a) Check painted areas for damaged or worn surface treatment.

(b) Check any exposed metal for corrosion.

(c) Check actuator cover for dents which might interfere with operation.

3. Cleaning/Painting

A. Clean valve bore and exterior surface.

(1) Use a soft lintless cloth moistened with solvent, Specification AMS 3160A to wipe off dirt and grease deposits.

CAUTION: DO NOT IMMERSE VALVE IN CLEANER.

(2) Remove corrosion using fine crocus cloth.

B. Touch up paint damage when total damage does not exceed five percent of the total painted area. Use zinc chromate primer, Specification AMS 3110C and black enamel, Specification AMS 3120B; allow paint to dry at least four hours at room temperature.

4. Approved Repair

A. Repair valve by replacing actuator when required (see Figure 201).

(1) Open CAB FLT DECK AIR SHUTOFF circuit breaker.

(2) Disconnect electrical connector from valve actuator. (Cap connector.)

(3) Remove actuator by removing retaining nuts and washers.

(4) Hold new actuator in position with receptacle toward valve upstream and rotate valve disc until shaft splines line up with actuator splines.

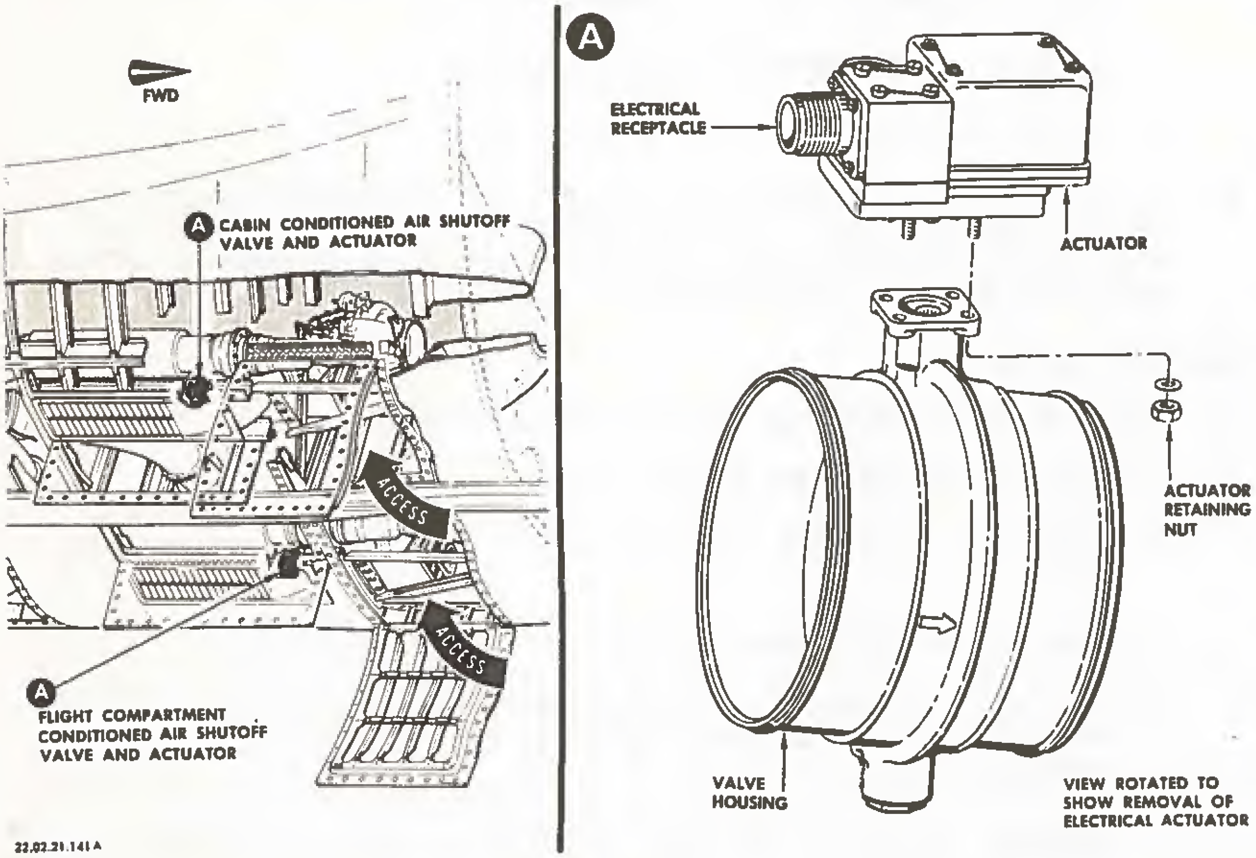
CAUTION: DO NOT ROTATE VALVE DISC WHEN ACTUATOR IS INSTALLED ON VALVE.

(5) Slide actuator onto shaft and secure with washers and nuts.

(6) Connect electrical connector to valve actuator.

(7) Close CAB-FLIGHT DECK AIR SHUTOFF circuit breaker.

(8) Perform operational check of system (refer to 21-0, Maintenance Practices).



Conditioned Air Emergency and
Crossover Shutoff Valve Actuator Installation
Figure 201

CROSSOVER SHUTOFF VALVE - MAINTENANCE PRACTICES

1. Removal/Installation Crossover Shutoff Valve

   A. Equipment Required - None.

   B. Preparation.

      (1) Open EVAP AIR MANF SHUTOFF VALVE circuit breaker. Place warning tag on open circuit breaker.

      (2) Remove the flight compartment (LH) Freon package (refer to 21-3-1, Maintenance Practices).

   C. Remove Crossover Shutoff Valve.

      (1) Disconnect electrical connector from the crossover shutoff valve actuator. Looking forward from the Freon package access door, the valve is just forward of the door opening and next to the centerline bulkhead. (Cap connector and receptacle. Tag harness for installation.)

      (2) Remove left and right hose clamps nearest the valve. (Tag for installation.)

      (3) Remove valve.

   D. Install Crossover Shutoff Valve.

      NOTE: The flight compartment Freon package must be removed for installation of the crossover shutoff valve.

      (1) Position valve between duct openings just forward of the access door and near the centerline bulkhead. The actuator shall be aft, and the electrical receptacle shall point outboard.

      (2) Position hoses and install hose clamps on left and right sides of valve.

      (3) Connect electrical connector to valve actuator.

      (4) Install flight compartment Freon package (refer to 21-3-1, Maintenance Practices).

      (5) Remove warning tag and close the EVAP AIR MANF SHUTOFF VALVE circuit breaker.

      (6) Perform operational check of system (refer to 21-0, Maintenance Practices).

2. For additional information on crossover shutoff valve maintenance practices, refer to 21-3-4, Maintenance Practices).

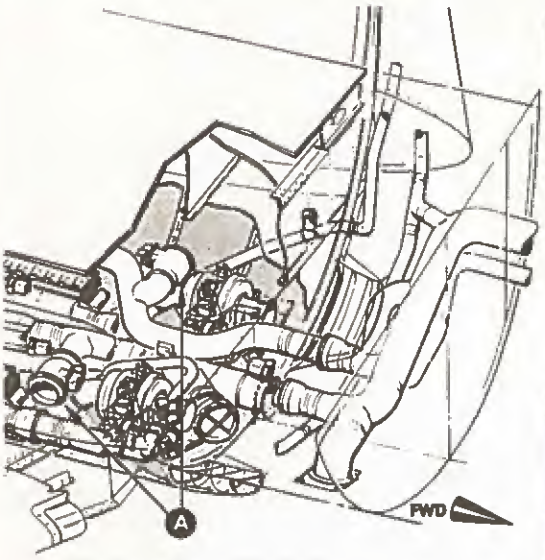
RAM AIR SHUTOFF VALVE - DESCRIPTION AND OPERATION

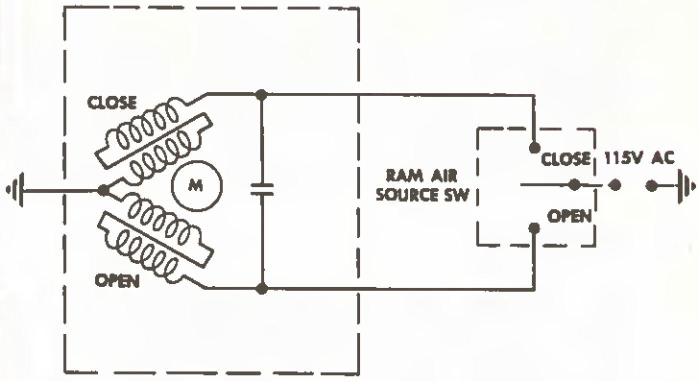
1. Description

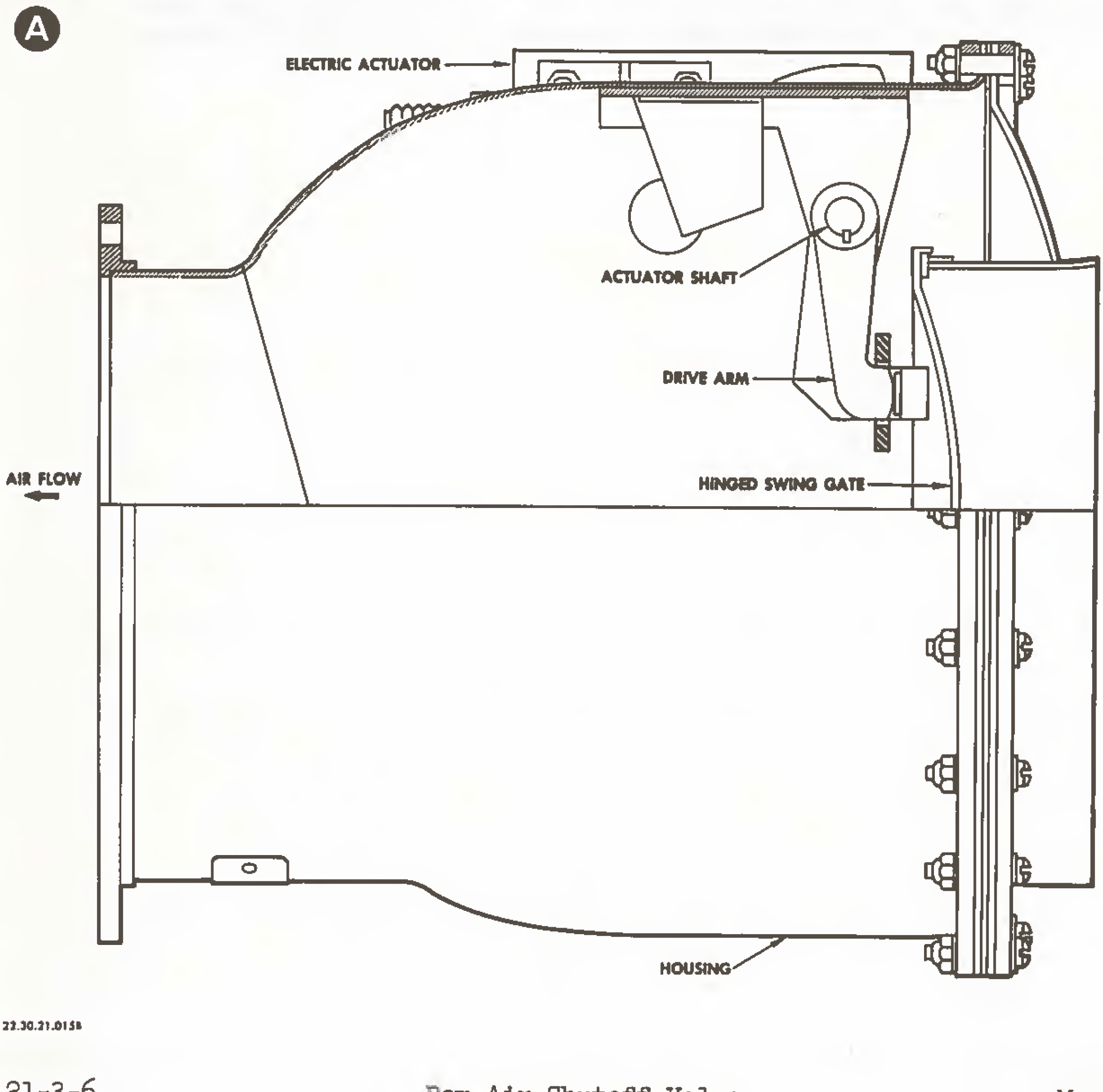
The ram air shutoff valves, shown on Figure 1, each contain a hinged gate and an electric actuator and drive arm. The actuator contains a two-phase electric motor, a gear train, and a capacitor. Wiring connects the actuator to ground and to the RAM AIR SOURCE switch on the flight engineer's control panel. The valves connect to the conditioned air supply ducts.

2. Operation

The valves provide an alternate means of supplying fresh air for cabin ventilation at altitudes below those requiring pressurization. The valves are opened only in the event both turbocompressors fail. Placing the RAM AIR SOURCE switches in the OPEN position applies 115-volt, ac power to the "open" winding of each valve actuator motor. Motor rotation, caused by the difference in phase established by the capacitor between the motor windings, rotate the actuator drive arm away from the hinged gate. The gate will open only when ram air pressure exceeds cabin pressure.







Ram Air Shutoff Valve
Figure 1

RAM AIR SHUTOFF VALVE - MAINTENANCE PRACTICES

1. Removal/Installation Ram Air Shutoff Valve.

   A. Equipment Required - None.

   B. Preparation.

      (1) Remove the turbocompressor package (cabin or flight compartment). (Refer to 21-1-0, Maintenance Practices.)

      (2) Open and place a warning tag on the RAM AIR SHUTOFF VALVE circuit breaker.

   C. Remove Ram Air Shutoff Valve.

      (1) Disconnect electrical connector from the ram air shutoff valve actuator. (Cap connector and receptacle. Tag harness for installation.)

      (2) Remove mounting bolts, nuts, and washers near the inlet end which secure valve to mounting bracket. (Bag and tag for installation.)

      (3) Remove flange mounting bolts, nuts, and washers which connect valve to duct. (Bag and tag for installation.)

      (4) Remove valve and gasket.

   D. Install Ram Air Shutoff Valve.

      NOTE: Turbocompressor package must be removed for installation of the ram air shutoff valve.

      (1) Position ram air shutoff valve with gasket against the duct opening.

         NOTE: Name plate of the cabin valve shall be on the bottom. Name plate of the flight compartment valve shall be at the 11 o'clock position looking outboard.

      (2) Install bolts, washers, and nuts to secure valve to duct.

      (3) Install bolts, washers and nuts to secure inlet end of valve to mounting bracket.

      (4) Connect electrical connector to valve actuator.

      (5) Remove warning tag and close the RAM AIR SHUTOFF VALVE circuit breaker.

         NOTE: Operational check of the ram air shutoff valve may be performed prior to installation of the turbocompressor package. Refer to 21-0, AIR CONDITIONING AND PRESSURIZATION.

(6) Install turbocompressor package (refer to 21-1-0, Maintenance Practices).

(7) Perform operational check of system if the ram air shutoff valve was not checked prior to installation of turbocompressor package.

2. Inspection/Check

A. Check Shaft and Flapper Movement of Valve.

(1) With the actuator cycled to open position, manually actuate flapper and shaft to open position and note any binding or restriction to movement.

3. Cleaning/Painting

A. Clean Ram Air Shutoff Valve.

(1) Remove external grease and oil deposits with solvent Specification AMS 3160A applied with a soft lintless cloth. Dry thoroughly.

NOTE: Do not allow solvent to enter the electrical actuator.

B. Paint Shutoff Valve.

(1) Touch up worn or damaged paint when damage does not effect a large area.

(a) Remove corrosion with steel wool or fine crocus cloth.

(b) Mask off nameplate and connecting flanges.

(2) Apply a priming coat of zinc chromate, Specification AMS 3110C to obtain a thick greenish yellow surface.

(3) Allow primer to dry 30 minutes at room temperature.

(4) Apply two coats of glyceryl phthalate black enamel, Specification AMS 3120B.

(5) Allow paint to dry four hours between coats before installation.

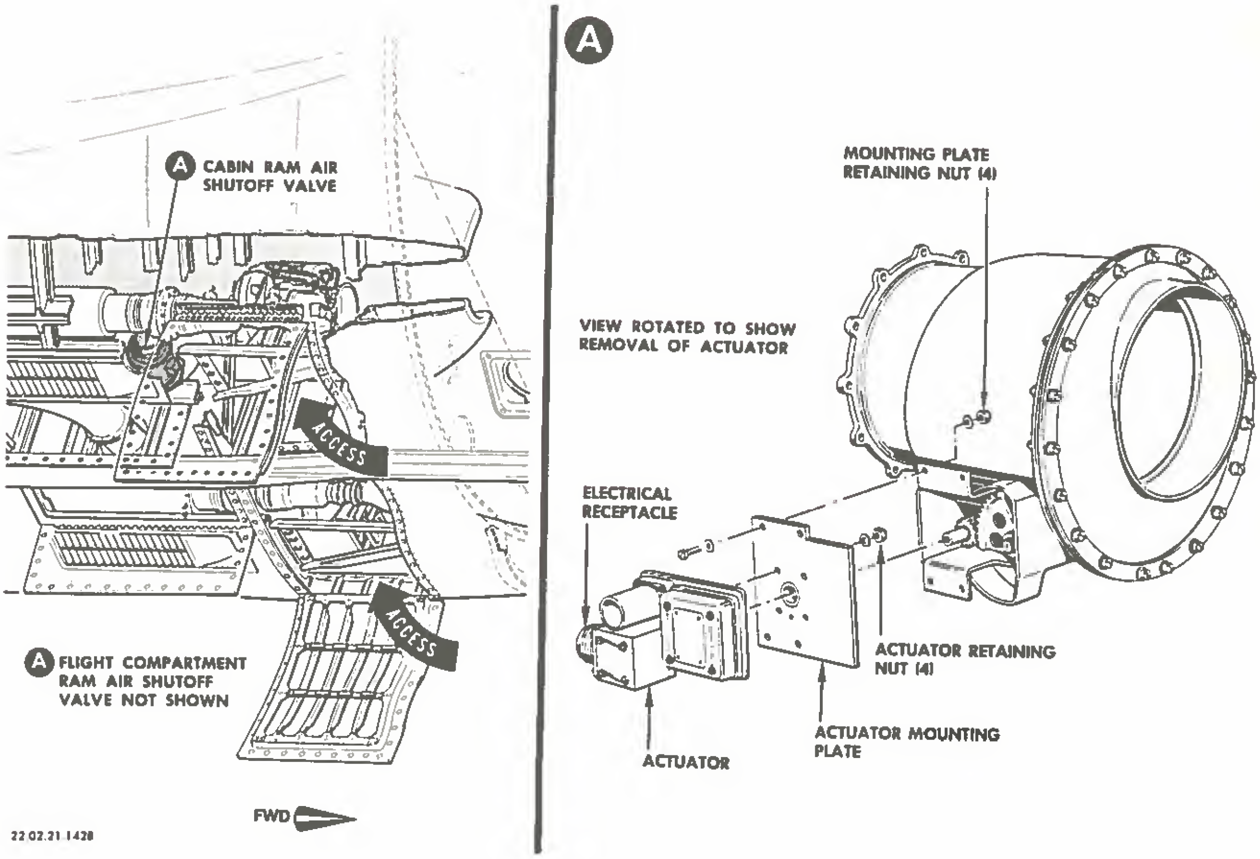
4. Approved Repairs

A. Remove Malfunctioning Actuator. (See Figure 201.)

(1) Open and place a warning tag on the RAM AIR SHUTOFF VALVE circuit breaker.

(2) Disconnect electrical connector from valve actuator.

(3) Remove four mounting plate retaining nuts, bolts, and washers. (Bag and tag for installation.)



Ram Air Shutoff Valve Actuator Installation
Figure 201

(4) Separate actuator and mounting plate from valve.

(5) Remove four actuator retaining nuts and washers. (Bag and tag for installation.)

(6) Separate actuator from mounting plate.

B. Install Actuator. (See Figure 201.)

(1) Position actuator on mounting plate so that alignment pin of the actuator fits into hole provided on mounting plate.

(2) Install four washers and nuts to secure actuator to mounting plate.

(3) Position actuator and mounting plate on valve with electrical connector pointing toward duct end of valve housing. (See Figure 201.)

(4) Install four bolts, washers, and nuts to secure mounting plate to valve housing.

(5) Connect electrical connector to valve actuator.

(6) Remove warning tag and close RAM AIR SHUTOFF VALVE circuit breaker.

(7) Check operation of valve.

C. Remove dents or distortion in the metal housing with a rawhide hammer.

D. Replace retaining bolt and nuts when required.

RECIRCULATION AND FRESH AIR CONTROL VALVES - DESCRIPTION AND OPERATION

1. Description (applicable to airplanes N802TW through N811TW)

The recirculation and fresh air control valves are eight inch electrically actuated butterfly valves, and are illustrated on Figure 1. The actuating motor in each valve is connected through a gear reduction train and splined shaft to a butterfly valve. The actuator housing also contains a closed position limit switch and position feedback potentiometer. Airplane wiring connects the valve actuators to the cabin electronic temperature control, cabin sequencing device, RECIRCULATING BLOWER ON-OFF switch, recirculation fan motor, and to the landing gear ground safety relays. Although the control valves supply air to both the cabin and flight compartment, valve control is maintained only by the cabin temperature control. The flight compartment temperature control has no effect on the valves.

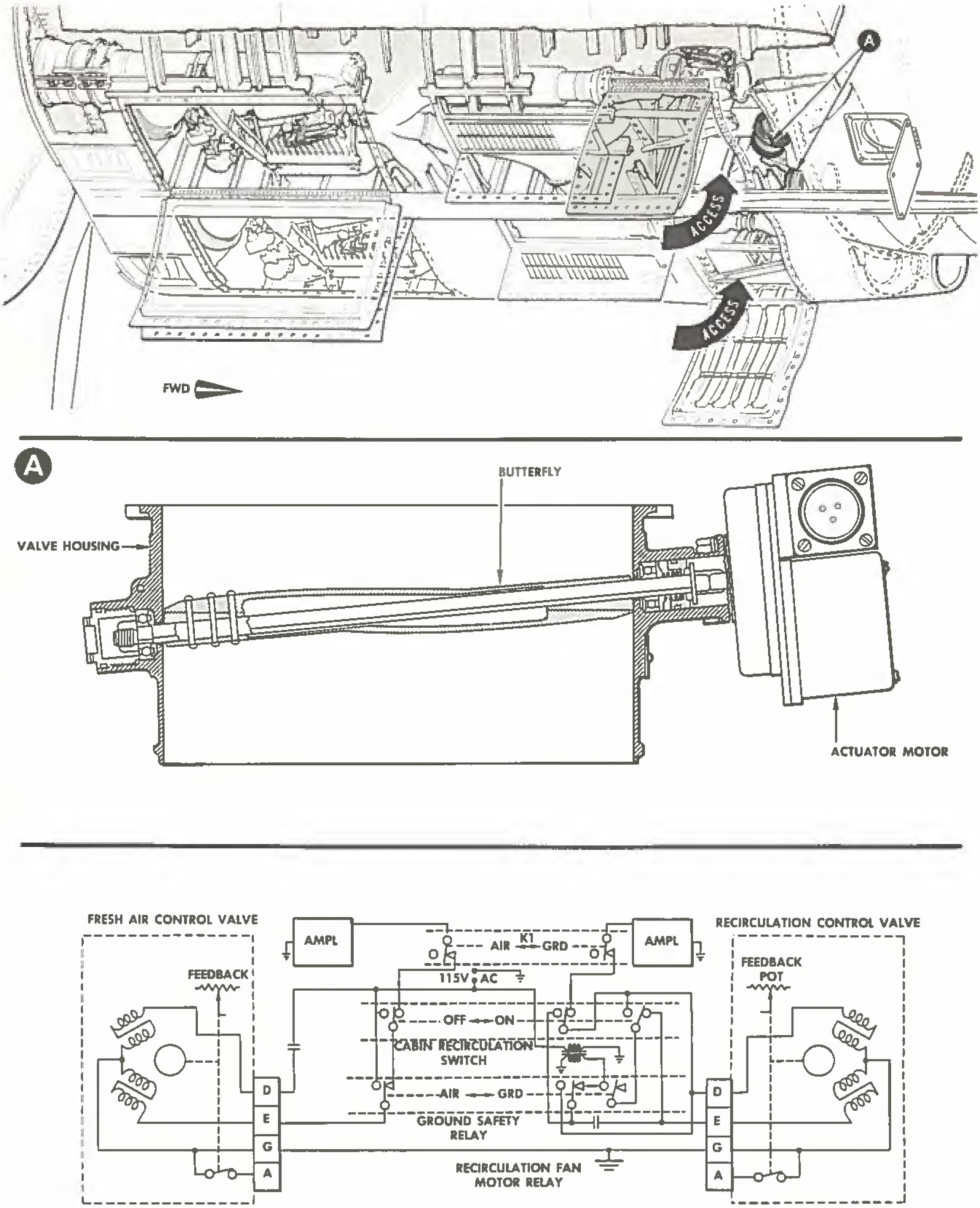
2. Operation

The recirculation control valve is used primarily during ground operations to provide adequate ventilation in the cabin and flight compartments. It is used in conjunction with the fresh air control valve and the recirculation fan to maintain a comfortable temperature. If there is only a slight difference in temperature inside and outside the airplane, the cabin temperature control will regulate temperature by varying the ratio of cabin air to fresh air. If further heating or cooling is required, the temperature control will operate the electric heaters or the Freon system when needed. When the recirculation fan is operated in flight, the recirculation control valve moves to the full open position, and the fresh air control valve remains closed. The fresh air control valve will not open when airborne.

When the recirculation control valve is open, it admits cabin air from the aft end of the forward cargo compartment to the recirculation fan. When the fresh air control valve is open, it admits fresh air from the plenum chamber to the recirculation fan. The output from the fan is directed through the normal air conditioning equipment and back into the cabin and flight compartments.

A. Actuator Motor.

The actuator motor is a servo motor with two phase windings. Motor rotation is caused by a phase difference in the power applied to the windings which are grounded through the closed limit switch and through the recirculation fan motor relay. Reference voltage of 115-volt, ac power is capacitance coupled to one winding of the fresh air control valve actuator at all times and control voltage connects to the opposite winding from the valves respective amplifiers, passing through closed contacts of the cabin electronic temperature control K1 relay, RECIRCULATING BLOWER ON-OFF switch, and the ground safety relay. Thus, the fresh air control valve modulation is interrupted by the K1 relay and the valve is closed by direct application of the 115-volt ac power when either the RECIRCULATING BLOWER switch is turned OFF or the airplane is airborne, actuating the ground safety relay to the "air" position.



(SCHEMATIC APPLICABLE TO AIRPLANES N802TW THRU N811TW)

22 30 21 014 B

Recirculation and Fresh Air Control Valves
Figure 1

TEMPORARY REVISION NO. 21-17.

Insert facing 21-3-7, Page 2 dated May 23/60.

Page 2; delete RECIRCULATION FAN MOTOR RELAY callout from schematic diagram.

Valve modulation of either valve is controlled by the temperature control system which causes control voltage from the amplifier to actuate the valves in accordance with matched potentiometer feedback and scheduled voltages.

B. Valve Modulation

Reference voltage for valve modulation is supplied to one winding of the recirculation control valve actuator across a phase shifting capacitor and through closed contacts of the ground safety relay while control voltage connects into the opposite winding from the amplifier through contacts of the K1 relay and the RECIRCULATING BLOWER switch. Valve modulation is interrupted by the K1 relay when the airplane is airborne and the valve closes when the RECIRCULATING BLOWER switch is turned OFF. Valve modulation can occur only when the airplane is on the ground since turning the RECIRCULATING BLOWER switch ON with the airplane airborne will fully open the valve (K1 open and 115-volt supplied through the ground safety switch and through the RECIRCULATING BLOWER switch).

3. Recirculation Control Valve (applicable to airplanes N801TW and N812TW through N830TW).

A. Description.

The recirculation control valves on these airplanes are the same valves as used on airplanes N802TW through N811TW, except in this configuration the valves are wired for manual control only. Airplane wiring connects the valve actuators to the cabin electronic temperature controller, RECIRCULATING BLOWER ON-OFF switch and the temperature control AUTO-OFF-MAN switch.

B. Operation.

In this application, the recirculation control valve operates in conjunction with the recirculation fan and is used primarily during ground operations. The valve is also used during flight when the recirculation fan is used to recirculate cabin air in the event one of the turbocompressors fail. When the recirculation valve is open, the recirculation fan draws air from the aft end of the forward cargo compartment.

Valve operation is accomplished by placing the RECIRCULATING BLOWER ON-OFF switch in the ON position. When in the ON position, 115-volt ac control voltage is applied to one winding of the valve actuator motor, and reference or capacitance coupled voltage is applied to the opposite winding to open the valve. When the switch is in the OFF position, the control and reference voltage are reversed to close the valve. Power is available to the RECIRCULATING BLOWER ON-OFF switch only when the TEMPERATURE CONTROL AUTO-OFF-MAN switch is in the AUTO or MAN position.

RECIRCULATION CONTROL VALVE - MAINTENANCE PRACTICES

1. Removal/Installation Recirculation Control Valve

   A. Equipment Required - None.

   B. Preparation.

      (1) Remove flight compartment (left side) turbocompressor package (refer to 21-1-0, Maintenance Practices).

      (2) Open RECIRC FAN CONT and cabin ELEC TEMP CONTROL circuit breaker. Place warning tag on open circuit breakers.

   C. Remove Recirculation Control Valve.

      (1) Disconnect electrical connector from the recirculation control valve actuator. Valve is located on duct near the centerline bulkhead, and about three inches from the forward bulkhead of the plenum chamber. (Cap connector and receptacle. Tag harness for installation.)

      (2) Disconnect aft end of valve by relasing hose clamp.

      (3) Disconnect forward end of valve by removing nuts, washers, and bolts from connecting flange. (Bag and tag hardware for installation.)

      (4) Remove valve and gasket.

   D. Install Recirculation Control Valve.

      NOTE: Flight compartment turbocompressor package must be removed for access to the recirculation control valve.

      (1) Position valve between opening in air duct. The connecting flange and gasket shall be forward. Valve actuator shall be at 7 o'clock position when viewed from aft end.

      (2) Install bolts, washers, and nuts in connecting flanges to secure forward end of valve to recirculation duct.

      (3) Position hose and install clamp to secure aft end of valve.

      (4) Connect electrical connector to valve actuator.

      (5) Remove warning tag and close RECIRC FAN CONT and ELEC TEMP CONTROL circuit breakers.

         NOTE: Operational check may be performed prior to installation of turbocompressor package (refer to 21-0, Maintenance Practices).

(6) Install turbocompressor package (refer to 21-1-0, Maintenance Practices).

(7) Perform operational check if it was not done prior to installation of turbocompressor package.

2. Inspection/Check

A. Examine the valve exterior. Parts shall be free from the damage described.

(1) Check the condition of actuator receptacle.

(a) Look for damaged or worn threads.

(b) Check pins for looseness or bending.

(2) Examine inlet and outlet connecting beads for cracks, scratches, grooves or other damaged that might cause leakage.

(3) Check the actuator mounting bolts and shaft end plug for tightness.

(4) Examine all surfaces for damage or wear.

(a) Check painted areas for damaged or worn surface treatment.

(b) Check any exposed metal for corrosion.

(c) Check actuator cover for dents that might affect operation.

3. Cleaning/Painting

A. Clean the valve bore and exterior surface with solvent, Specification AMS 3160A to wipe off dirt and grease deposits.

CAUTION: DO NOT IMMERSE THE VALVE IN CLEANER.

(1) Remove corrosion using a fine crocus cloth.

B. Touch up paint damage when total damage does not exceed 5 percent of the total painted area. Use black enamel Specification AMS 3120B and allow paint to dry at least 4 hours at room temperature.

4. Approved Repair

A. Repair the valve by actuator replacement when required. (See Figure 201.)

(1) Remove actuator by removing nuts and washers.

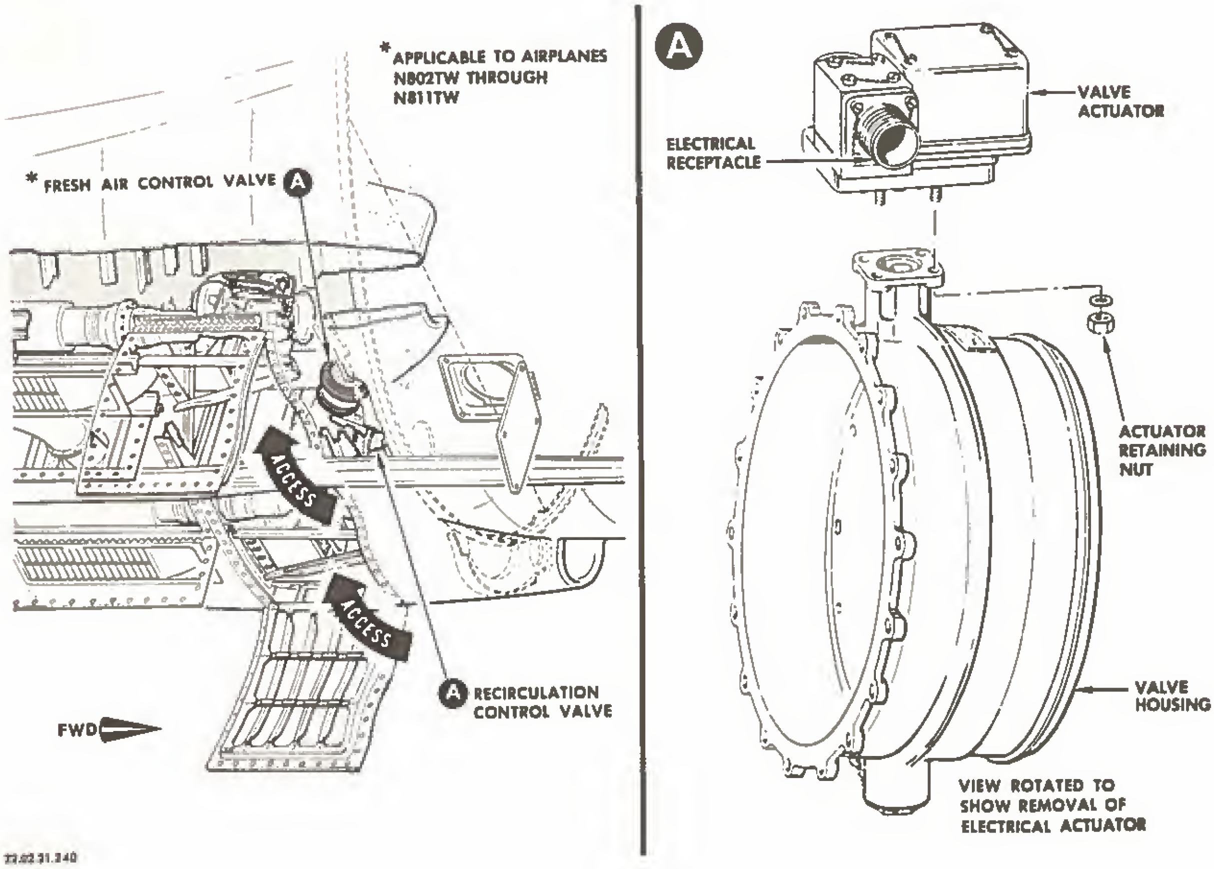
(2) Hold new actuator in position over the shaft and rotate valve disc until shaft splines line up with actuator splines.

(3) Connect actuator to valve and secure with retaining nuts and washers.

CAUTION: DO NOT ROTATE VALVE DISC WHEN ACTUATOR IS INSTALLED ON VALVE.

(4) Check valve performance.

B. Additional valve repair is limited to corrosion removal and paint re-touching.



Recirculation and Fresh Air
Control Valve Actuators Installation
Figure 201

FRESH AIR CONTROL VALVE - MAINTENANCE PRACTICES

1. Removal/Installation Fresh Air Control Valve (applicable to airplanes N802TW through N811TW)

   A. Equipment Required - None.

   B. Preparation.

      (1) Remove cabin (RH) turbocompressor package (refer to 21-1-0, Maintenance Practices).

      (2) Open RECIRC FAN CONT and cabin ELEC TEMP CONTROL circuit breakers. Place warning tag on open circuit breakers.

   C. Remove Fresh Air Control Valve.

      (1) Disconnect electrical connector from the fresh air control valve. The fresh air control valve is connected to the fresh air check valve, and both are mounted on a short duct section which extends forward and to the right from the centerline bulkhead. (Cap connector and receptacle. Tag harness for installation.)

      (2) Remove mounting clamp which secures check valve to mounting bracket in airplane. (Tag for installation.)

      (3) Locate connecting flange between the fresh air control valve and the fresh air check valve. Remove four flange bolts which also extend through mounting bracket at bottom of flange. (Tag hardware for installation.)

      (4) Remove three nuts which secure tie rods to connecting flange. (Bag and tag for installation.)

      (5) Remove hose clamp at aft end of fresh air control valve.

      (6) Remove the assembled control valve and check valve.

         NOTE: If further disassembly is required, mark the location of the four mounting bracket holes and three tie rod holes in connecting flange. If a new valve is to be installed, these marks must be transferred to the new part.

      (7) Separate the two valves by removing the nuts and bolts from the connecting flanges. (Bag and tag hardware for installation.)

   D. Install Fresh Air Control Valve.

      NOTE: The cabin (right side) turbocompressor package must be removed.

(1) Assemble the fresh air control valve and fresh air check valve by installing bolts in the connecting flanges.

NOTE: Do not install bolts in the four mounting bracket holes or the three tie rod holes. Identify these holes from markings on the removed component. If the removed components are not available, the location of these holes can be determined by a trial position of the valves. Place the fresh air control valve against the duct opening with the valve actuator pointing down and aft. When the position is found that will prevent the valve actuator from touching adjacent parts, mark the four mounting bracket holes and the three tie rod holes.

(2) Position the assembled control valve against the duct opening. Rotate assembly on mounting bracket until the vacant mounting bracket holes and tie rod holes are properly aligned.

(3) Install bolts and nuts through four mounting bracket holes to secure connecting flange to bracket.

(4) Install nuts to secure three tie rods to the connecting flange.

(5) Secure hose connection at aft end of fresh air control valve.

(6) Install clamp to secure fresh air check valve to mounting bracket.

(7) Connect electrical connector to control valve actuator.

(8) Remove warning tag and close RECIRC FAN CONT and cabin ELEC TEMP CONTROL circuit breakers.

NOTE: Operational check may be performed prior to installation of turbocompressor package. Operate the recirculation fan and manually toggle the cabin temperature control MAN HOT-MAN COLD switch to MAN HOT; then toggle to MAN COLD. The fresh air control valve shall open during the sequence, but it may not remain open. Operating schedule depends upon difference in temperature inside and outside the airplane, and upon whether heating or cooling is required to reach the scheduled temperature.

(9) Install cabin turbocompressor package (refer to 21-1-0, Maintenance Practices).

(10) Check operation of the fresh air control valve if test was not performed prior to installation of turbocompressor package.

2. <u>For additional information on fresh air control valve maintenance practices, refer to 21-3-7, Maintenance Practices.</u>

HEAT EXCHANGER COOL AIR MODULATING VALVE - DESCRIPTION AND OPERATION

1. Description

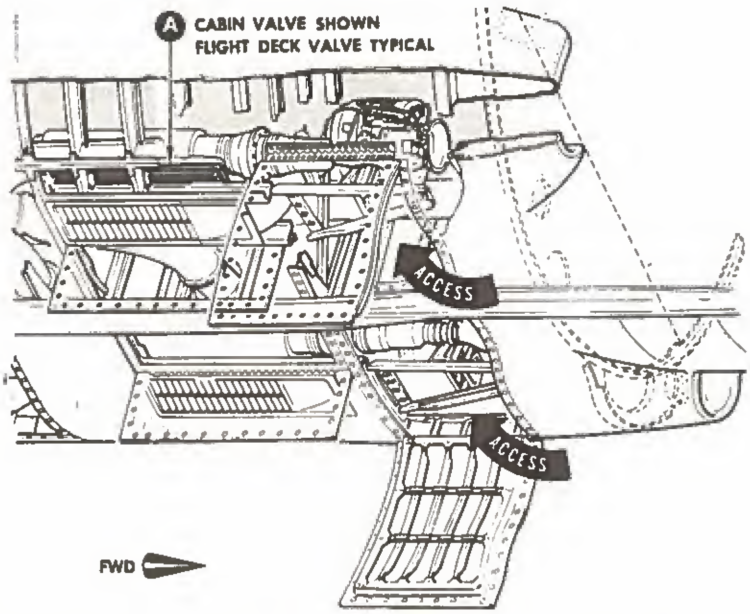
The cool air modulating valve, shown on Figure 1, is a louver type, electrically-actuated, rectangular valve that mounts over the ram air inlet of the heat exchanger. The valve has an electric actuator that contains a feedback potentiometer, an electric motor and reduction gear train. The actuator is splined to a drive lever that operates the valve shutters or louvers through a cam arrangement connected to the shutter linkage. Wiring harnesses connect the actuator to ground, electronic temperature control, temperature control AUTO-OFF-MAN switch, the 160 degree F thermal switch, and the manual temperature control MAN HOT-MAN COLD switch.

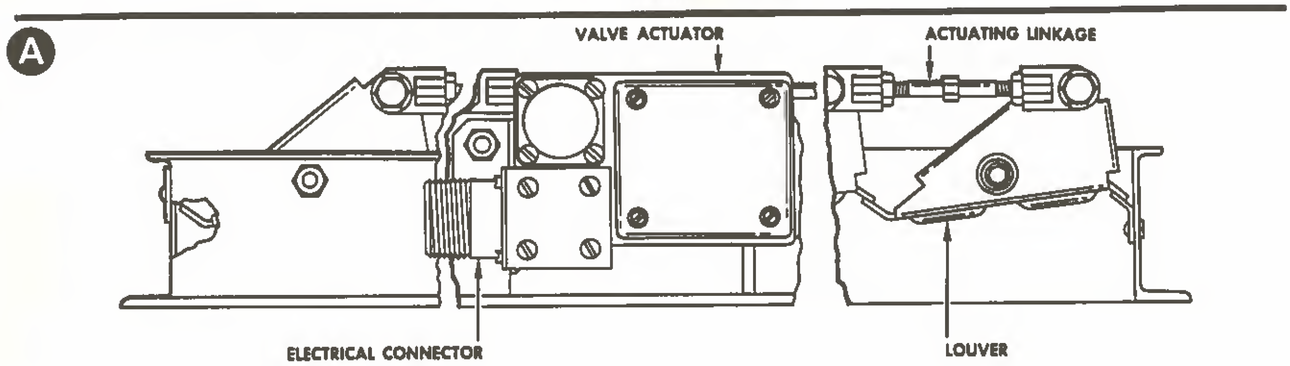
2. Operation

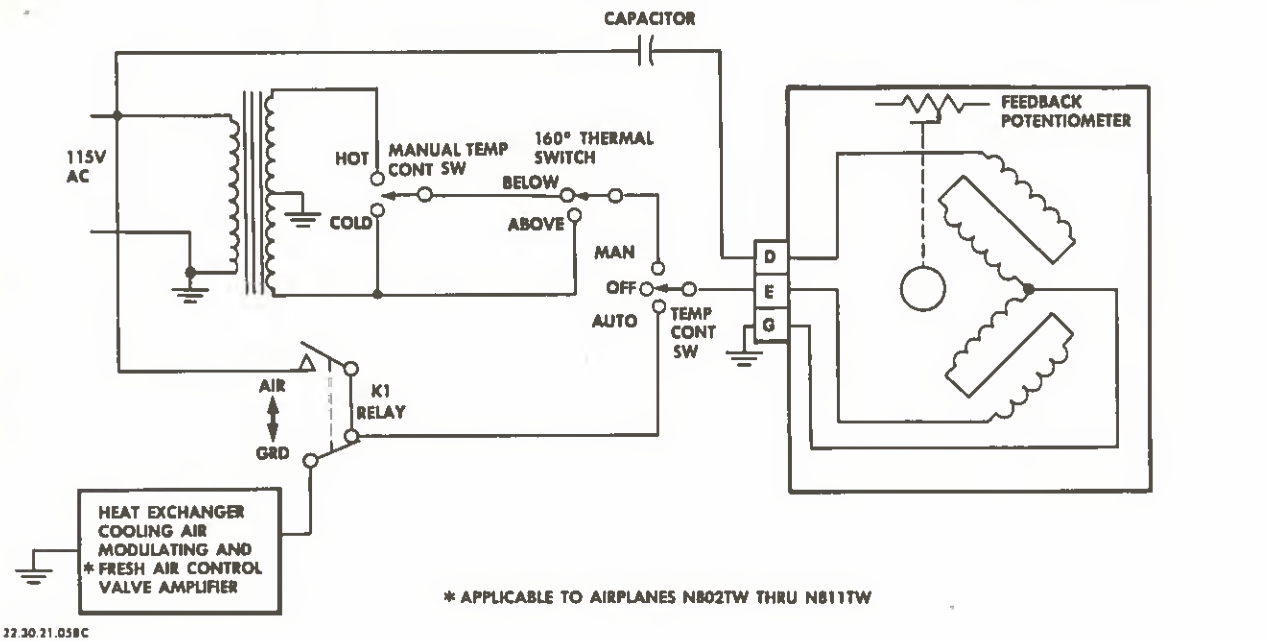
The cool air modulating valve regulates the ram air flow through the heat exchanger. The valve is inoperative during ground operation but is subject to modulation when the airplane is airborne. The valve is automatically or manually controlled. The actuator motor is a servo motor with two phase windings. Motor rotation is caused by a phase difference in power applied to the windings. Reference voltage of 115-volt, ac power is capacitance coupled to one motor winding at all times and control voltage for valve modulation connects to the opposite winding from the amplifier output through closed contacts of the K1 relay and the temperature control AUTO-OFF-MAN switch (AUTO position).

Valve modulation is controlled by the temperature control system which causes control voltage from the amplifier to actuate the valve in accordance with matched potentiometer feedback and scheduled voltages.

When the temperature control AUTO-OFF-MAN switch is placed in the MAN position, the control voltage is shifted from the amplifier to 115-volt ac through the 160 degree F thermal switch "cold" contact and the manual temperature control MAN HOT-MAN COLD switch (in MAN HOT position). This switch arrangement closes the valve. If the 160 degree F thermal switch actuates or the manual temperature control MAN HOT-MAN COLD switch is placed in the MAN-COLD position, the valve will open by application of the 115-volt ac (phase shifted 180 degrees) to the control winding.







Heat Exchanger Cooling Air Modulating Valve
Figure 1

HEAT EXCHANGER COOLING AIR MODULATING VALVE - MAINTENANCE PRACTICES

1. Removal/Installation

   A. The heat exchanger cooling air modulating valve and the heat exchanger must be removed from the airplane as an assembled unit. After removal from the airplane, the two components are separated (refer to 21-3-2, Maintenance Practices).

TEMPORARY REVISION NO. 21-18.

Insert facing 21-3-10, Page 1 dated Dec. 5/60.

This temporary revision is applicable to airplanes after incorporation of Service Bulletin 21-32.

21-3-1, Page 1 dated Dec. 5/60 is applicable prior to incorporation of Service Bulletin 21-32.

CONDENSER COOLING AIR SHUTOFF VALVE

1. Description

The condenser cooling air shutoff valve, shown on Figure 1, is a nine-inch electrically-actuated butterfly valve. The valve has an electric actuator that contains a position switch, and an electric motor and gear train with open and closed position limit switches. The actuator is splined to the butterfly valve. Wiring harnesses connect the actuator to 115-volt ac power through the condenser cooling control relay, to the condenser fan motor relay, sequencing device and control switches.

2. Operation

The condenser cooling air shutoff valve controls the airflow through the Freon condenser during ground operation, or at low airspeeds when the condenser cooling air pressure switch is actuated. A limit switch closes when the valve reaches the full open position and completes a circuit to the condenser fan motor relay to operate the condenser fan. The actuator motor is a servo motor with a two-phase winding. Motor rotation is caused by the difference in phase established between the windings by a capacitor.

During ground operation, 115-volt ac power is applied through the condenser cooling control relay to one winding, opening the valve. If the airplane is airborne, and ram air pressure in the plenum chamber is sufficient to prevent the condenser cooling air pressure switch from actuating, the condenser cooling control relay removes the power supplied to the open winding and applies this power to the close winding, closing the valve. During ground operations of the Freon package, airflow through the condenser is induced by the condenser fan; hence, the signal to trip the condenser fan motor relay "on" is provided by the valve position limit switch. Thus, when the valve opens, the fan starts and cooling air is drawn through the condenser, valve, and fan and is discharged into the landing gear wheel well.

CONDENSER GROUND COOLING AIR SHUTOFF VALVE - DESCRIPTION AND OPERATION

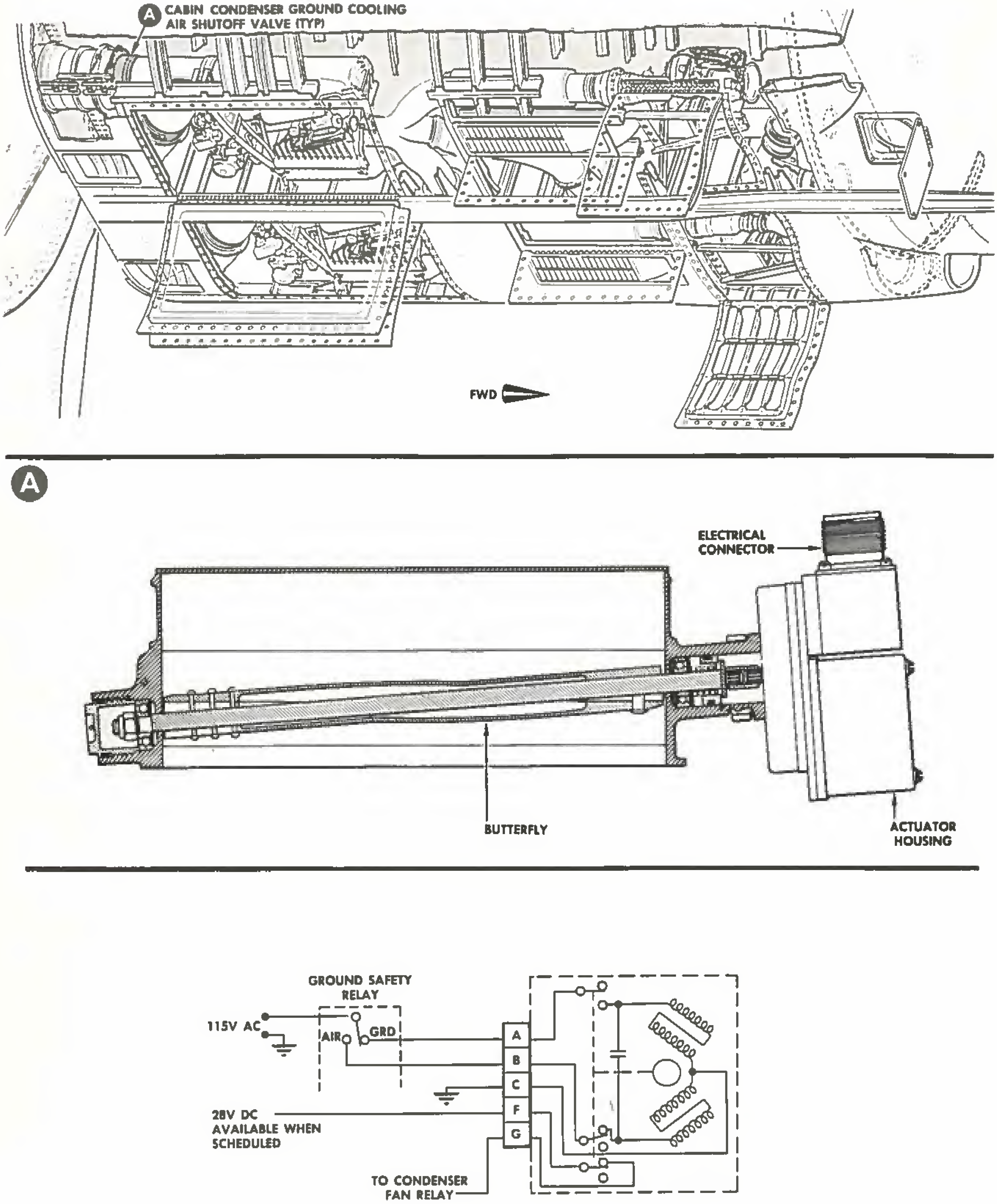
1. Description

The condenser cooling air shutoff valve is a nine-inch electrically actuated butterfly valve and is illustrated on Figure 1. The valve has an electric actuator that contains a position switch, electric motor and gear train with open and closed position limit switches. The actuator is splined to the butterfly valve. Wiring harnesses connect the actuator to 115-volt ac power through the landing gear down and locked relay.

2. Operation

The condenser cooling air shutoff valve controls the air flow through the Freon condenser during system operation when the airplane is on the ground, or at low airspeeds when the landing gear is down and locked. A limit switch closes when the valve reaches the full open position and completes a circuit to the condenser fan motor relay to operate the condenser fan. The electric motor of the actuator is a servo motor with two phase windings. Motor rotation is caused by the difference in phase established between the windings by the capacitor. Thus, power applied to one winding is capacitance coupled to the opposite winding causing a phase shift in voltage applied to that winding.

During ground operation, 115-volt ac power is applied through the landing gear down and locked relay to one winding, opening the valve. If the airplane is airborne, the down and locked relay removes the power supplied to the "open" winding and applies this power to the "close" winding closing the valve. During ground operation of the Freon package, the airflow through the condenser is induced by the condenser fan; hence, the signal to trip the condenser fan motor relay "on" is provided by the valve position switch. Thus, when the valve opens, the fan starts and cooling air is drawn through the condenser, valve, fan, and discharge port.



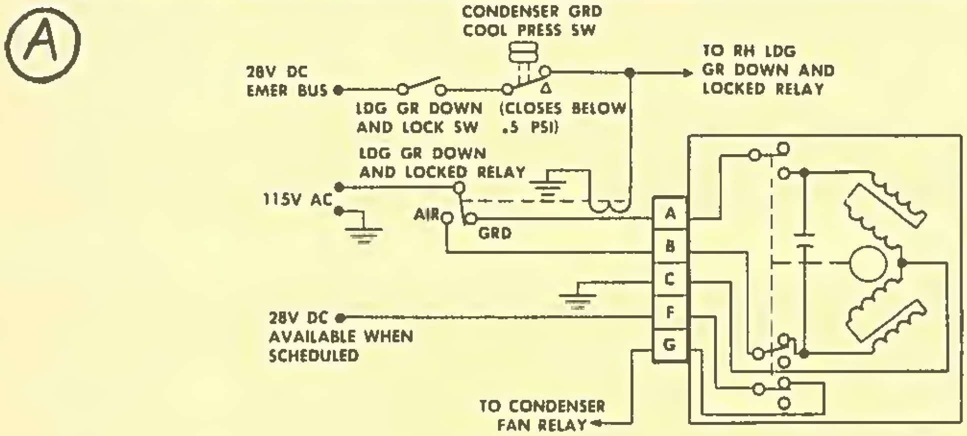
22.30.21.057A

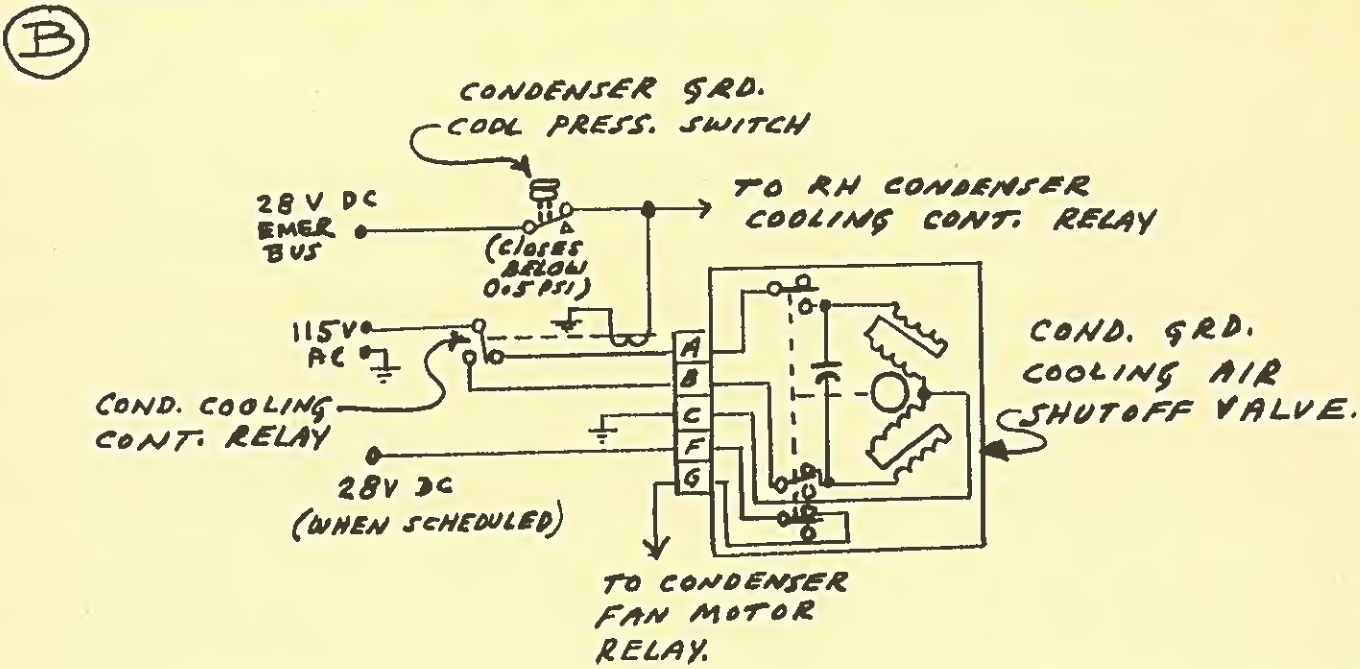
Condenser Ground Cooling Air Shutoff Valve
Figure 1

TEMPORARY REVISION NO. 21-19.

Insert facing 21-3-10, Page 2 dated May 23/60.

Page 2; The schematics shown below in details A and B replace the schematic on Figure 1. Detail A is applicable to airplanes prior to incorporation of Service Bulletin 21-32. Detail B is applicable after incorporation of Service Bulletin 21-32.





CONDENSER GROUND COOLING AIR SHUTOFF VALVE - MAINTENANCE PRACTICES

1. Removal/Installation Condenser Ground Cooling Air Shutoff Valve (see Figure 201).

   A. Equipment Required - None.

   B. Preparation.

      (1) Remove Freon package for access to valve (refer to 21-3-1, Maintenance Practices).

      (2) Open COND GND COOLING circuit breaker (cabin or flight deck as required). Place warning tag on open circuit breakers.

      (3) Remove three 30 ampere FREON COND CABIN, or FREON COND FLT DECK fuses from the ac power distribution panel. (Bag and tag for installation.)

      WARNING: DO NOT OPEN THE AC POWER DISTRIBUTION PANEL WHEN THE BATTERY IS ON, THE ENGINES ARE RUNNING, OR WHEN EXTERNAL POWER IS CONNECTED TO THE AIRPLANE.

   C. Remove Condenser Ground Cooling Air Shutoff Valve.

      (1) Remove clamps securing branched duct to shutoff valve, and modulating valve at aft edge of Freon package access door. (Tag for installation.)

      (2) Reaching aft from the access door, disconnect electrical connector from the shutoff valve actuator and power leads from the condenser fan motor.

      CAUTION: TAG MOTOR LEADS FOR IDENTIFICATION UPON INSTALLATION.

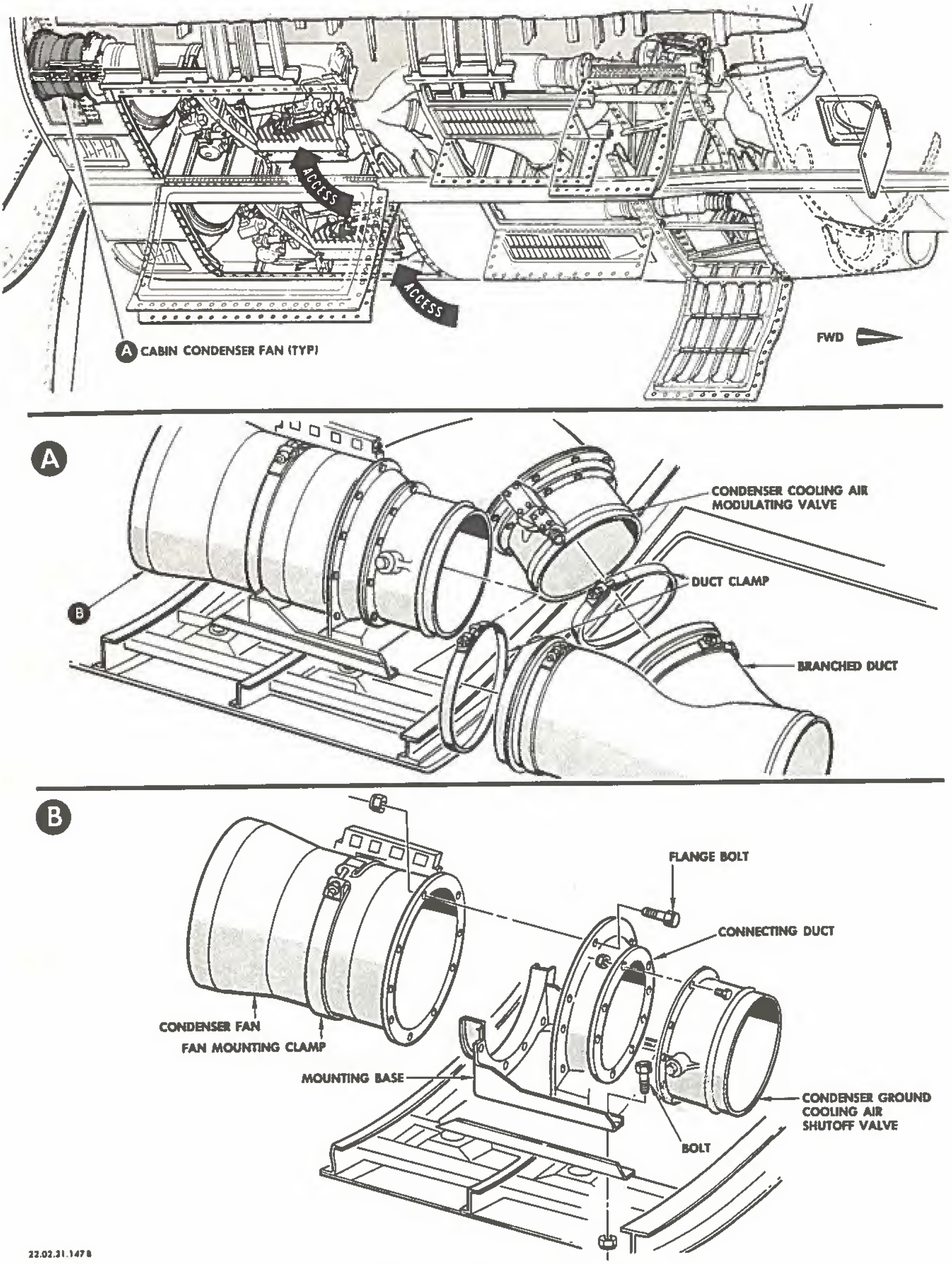
      (3) Remove clamp securing fan to wheel well discharge duct. (Tag for installation.)

      (4) Remove nuts and bolts securing unit mounting frame to airplane mounting frame. (Bag and tag for installation.)

      NOTE: The condenser ground cooling air shutoff valve and the condenser fan are installed in the airplane as an assembled unit.

      (5) Slide the fan and valve unit forward. Disconnect ground strap and remove through the Freon package access door.

      (6) Separate valve by removing bolts from the connecting duct flange. (Bag and tag hardware for installation.)



Condenser Ground Cooling
Air Shutoff Valve and Condenser Fan Installation
Figure 201

D. Install Condenser Ground Cooling Air Shutoff Valve.

(1) Assemble the valve to the unit mounting frame connecting duct by installing bolts and nuts in the connecting flanges. The valve actuator shall be placed 120 degrees clockwise from the top when viewing valve end of unit.

(2) Place assembled unit on airplane mounting bracket, connect grounding strap, and slide aft to engage the locating pins. Fan must align with wheel well discharge duct at aft end.

(3) Install two bolts and nuts to secure forward end of assembled unit.

(4) Install and tighten clamp to secure fan to discharge duct.

(5) Connect power leads to fan motor.

CAUTION: CHECK IDENTIFICATION TAGS FOR PROPER TERMINAL CONNECTIONS.

(6) Connect electrical connector to valve actuator.

(7) Position branched condenser discharge duct and secure to shutoff and modulating valves with hose and clamps.

(8) Install Freon package (refer to 21-3-1, Maintenance Practices).

(9) Install three 30 ampere FREON COND CABIN or FLT DECK fuses in the ac power distribution panel.

CAUTION: DO NOT OPEN THE AC POWER DISTRIBUTION PANEL WITH THE BATTERY ON, THE ENGINES RUNNING, OR WITH EXTERNAL POWER CONNECTED TO THE AIRPLANE.

(10) Remove warning tag and close the COND GND COOLING circuit breaker.

(11) Operate air-conditioning system and perform functional check (refer to 21-0, Maintenance Practices).

2. Cleaning/Painting

A. Clean the valve bore and exterior surfaces.

(1) Use a soft lintless cloth moistened with solvent, Specification AMS 3160A to wipe off dirt and grease deposits.

CAUTION: DO NOT IMMERSE THE VALVE IN CLEANER.

(2) Remove corrosion using a fine crocus cloth.

B. Touch up paint damage when total damage does not exceed 5 percent of the total painted area. Use black enamel, Specification AMS 3120B and allow paint to dry at least 4 hours at room temperature.

3. Approved Repair

A. Repair the valve by actuator replacement when required.

(1) Remove actuator by removing retaining nuts and washer.

(2) Hold new actuator in position over the shaft (with receptacle toward valve upstream) and rotate valve disc until shaft splines line up.

(3) Assemble actuator to valve securing with retaining washers and nuts.

(4) Check valve performance.

B. Additional valve repair is limited to corrosion removal and paint retouching.

TEMPORARY REVISION NO. 21-20.

Insert facing 21-3-11, Page 1 dated May 25/61.

This temporary revision is applicable to airplanes after incorporation of Service Bulletin 21-32.

21-3-11, Page 1 dated May 25/61 is applicable prior to incorporation of Service Bulletin 21-32.

CONDENSER FAN

1. Description

   The condenser fan, shown on Figure 1, is a ten-inch axial flow type fan powered by an induction motor. The motor contains a normally open self-resetting thermal switch that is connected to a lockout relay on the fan housing. The fan is connected to electrical power through the condenser fan motor relay. The motor relay is grounded through the lockout relay and connects to 28-volt dc power through the condenser ground cooling air shutoff valve position switch, condenser cooling control relay, sequencing device, FREON COMPRESSOR FLT DECK OFF-BOTH ON-CABIN OFF control switch and the Freon compressor ON-OFF switch.

2. Operation

   The condenser fan induces an airflow through the Freon condenser when the airplane is on the ground, or at low airspeeds when ram air cooling is insufficient. Operation at low airspeeds is controlled through a pressure switch and the condenser cooling control relays. When cooling is scheduled, and the condenser ground cooling air shutoff valve is open, 28-volt dc power energizes the fan motor relay. The closed contacts of the relay provides 115/200-volt, 3 phase, ac power to the fan motor windings. If the fan motor overheats during operation, a thermal switch closes a circuit which trips the lockout relay, thus deenergizing the motor by interrupting ground. The fan is then inoperative until the lockout relay has been manually reset by means of a push button on the fan housing. The thermal switch resets automatically when the fan motor temperature returns to normal.

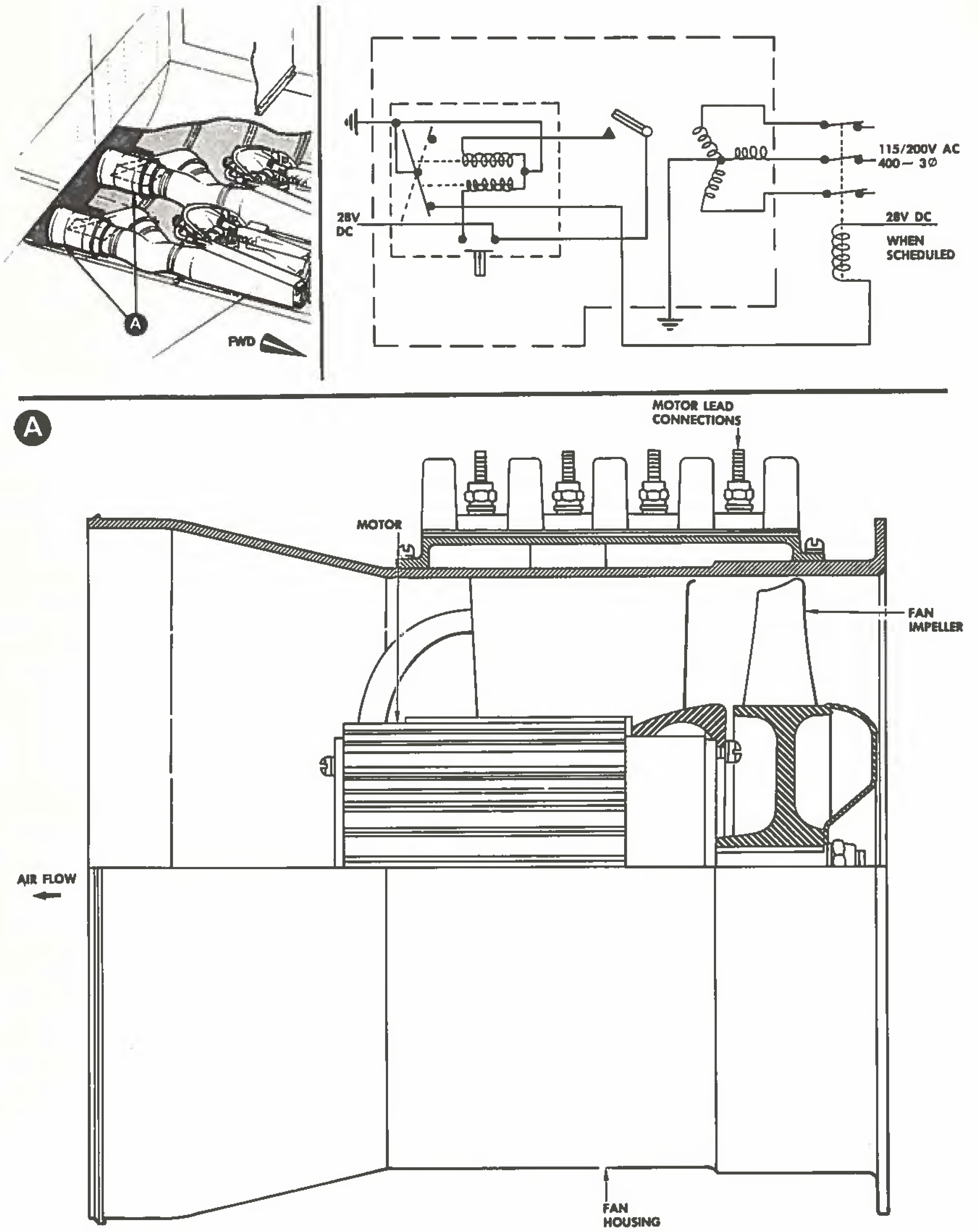
CONDENSER FAN - DESCRIPTION AND OPERATION

1. Description

The condenser fan shown on Figure 1 is a ten-inch axial flow type fan, powered by an induction motor. The motor contains a normally open self-resetting thermal protective switch that is connected to a lockout relay on the fan housing. The fan is connected to electrical power through the condenser fan motor relay. The motor relay is grounded through the lockout relay and connects to 28-volt dc power through the condenser ground cooling air shutoff valve position switch, landing gear down and locked relay sequencing device, FREON COMPRESSOR FLT DECK OFF-BOTH ON-CABIN OFF control switch and the Freon compressor ON-OFF switch.

2. Operation

The condenser fan induces an airflow through the Freon condenser when the airplane is on the ground, or at low airspeeds when ram air cooling is insufficient. Operation at low airspeeds is controlled through a pressure switch and the landing gear down and locked relay No. 1. Airborne operation is obtained only when the gear is down and locked and the ram air pressure drops below an acceptable minimum. When cooling is scheduled and the condenser ground cooling air shutoff valve is open, 28-volt dc power energizes the fan motor relay. The closed contacts of the relay provide 115/200-volt, 3 phase, ac power to the "Y" connected fan motor windings. If the fan motor overheats during operation, a thermal switch closes a circuit that trips the lockout relay, thus de-energizing the motor relay by interrupting ground. The fan is then inoperative until the lockout relay has been manually reset by means of a push button on the fan housing. The thermal switch resets itself automatically when the fan motor temperature returns to normal.



22.30.21.054

Condenser Fan
Figure 1

CONDENSER FAN - MAINTENANCE PRACTICES

1. Removal/Installation

   A. The condenser fan and the condenser ground cooling air shutoff valve are removed from the airplane as an assembled unit. After removal, the two components are separated (refer to 21-3-10, Maintenance Practices).

2. Adjustment/Test

   A. Operate the Freon package for approximately 15 minutes. There shall be no sign of overheating in the condenser fan.

      CAUTION: CHECK DIRECTION OF ROTATION OF THE CONDENSER FAN BY FEELING FOR AIR DISCHARGED AFT INTO THE MAIN LANDING GEAR WHEEL WELL. IF ROTATION IS WRONG, REVERSE ANY TWO POWER LEADS. DO NOT CHANGE GROUND LEAD T_o.

TEMPORARY REVISION NO. 21-21.

Insert facing 21-3-12, Page 1 dated Dec. 5/60.

This temporary revision is applicable to airplanes after incorporation of Service Bulletin 21-32.

21-3-12, Page 1 dated Dec. 5/60 is applicable prior to incorporation of Service Bulletin 21-32.

CONDENSER COOLING AIR MODULATING VALVE

1. Description

The cooling air modulating valve, shown on Figure 1, is a nine-inch electrically-actuated butterfly valve. The valve actuator contains an electric motor and gear train which is splined to the butterfly valve. The actuator is electrically connected through the condenser cooling control relay to the Freon compressor motor relay, condenser ground cooling shutoff valve and the condenser minimum temperature control.

2. Operation

Ram air discharge from the Freon condenser during cruising flight is controlled by modulating this valve. At low airspeeds, a pressure switch actuates to close the cool air modulating valve, open the ground cooling air shutoff valve, and start the condenser fan. Modulation signals originate in the condenser minimum temperature control. The actuator electric motor is a servo motor with two-phase windings. Motor rotation is caused by a phase difference in voltage applied to the motor windings. Reference voltage is 115-volt ac power from the condenser temperature control and is capacitance coupled to one winding of the valve actuator. Control voltage for valve modulation connects to the opposite winding from the condenser temperature control amplifier through closed contacts of the Freon compressor motor relay and condenser cooling control relay. If the Freon compressor is turned on, or ram air pressure falls below a predetermined minimun, 115-volts ac power is supplied to the control winding to close the valve. Thus, valve modulation is scheduled only in flight and only when cooling is scheduled provided that the temperature of the condenser discharge air is between 65 degrees F (18.3 degrees C) and 85 degrees F (29.4 degrees C). The valve will start closing when the condenser discharge air temperature reaches 65 degrees F, and will start opening when the air temperature reaches 85 degrees F.

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

1. [illegible]

The [illegible] Figure 1, is a [illegible] butterfly valve. The valve actuator [illegible] motor and gear train [illegible] of the butterfly valve. The [illegible]

[illegible]

[illegible] Figure 1 [illegible] a pressure [illegible]

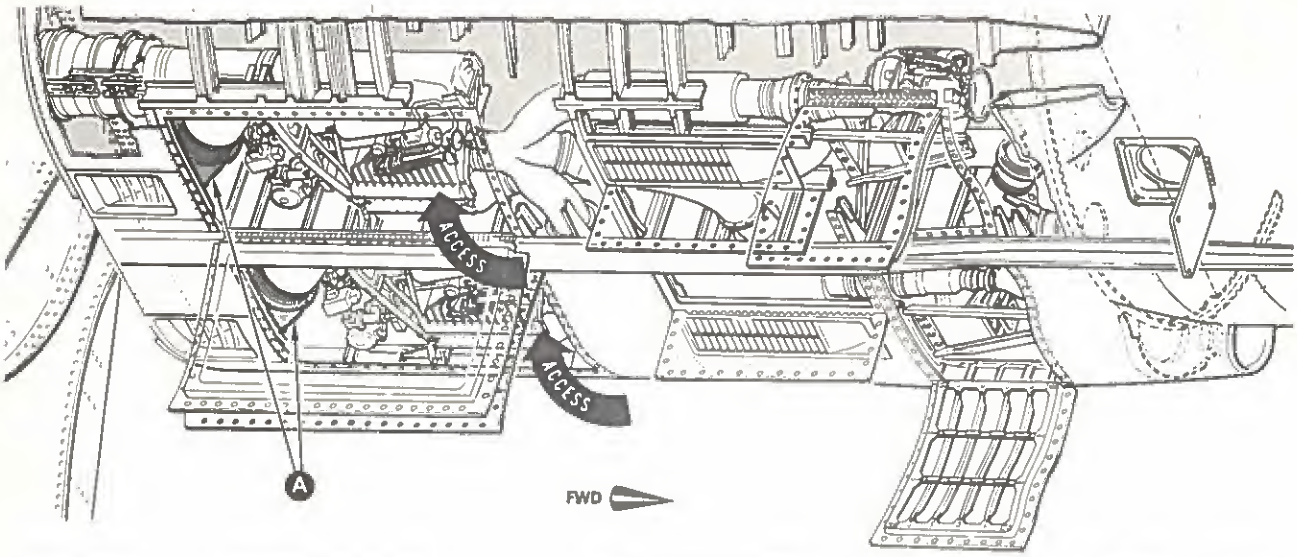
CONDENSER COOLING AIR MODULATING VALVE - DESCRIPTION AND OPERATION

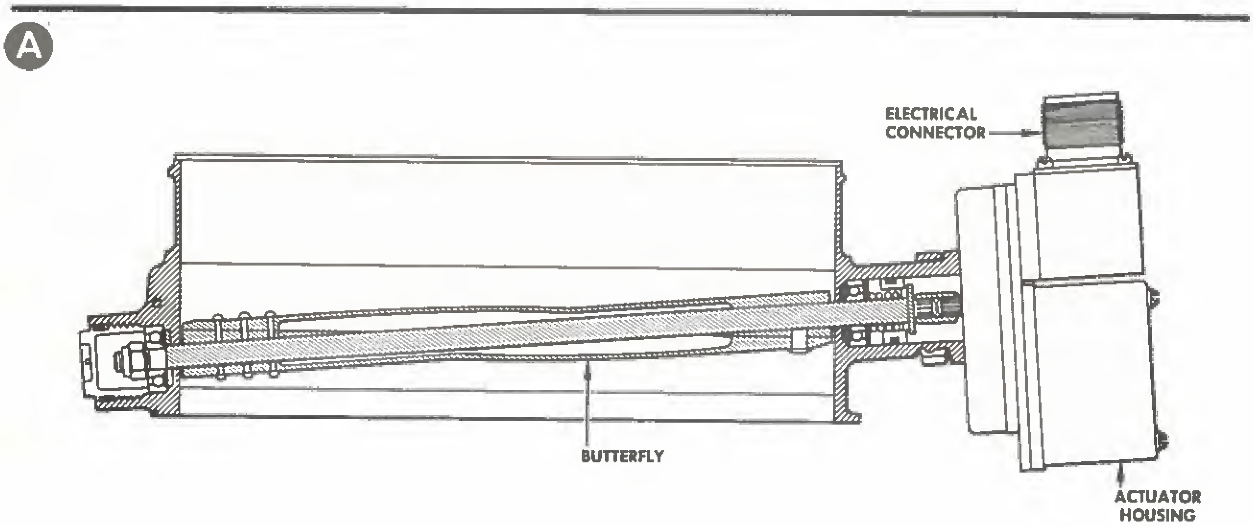
1. Description

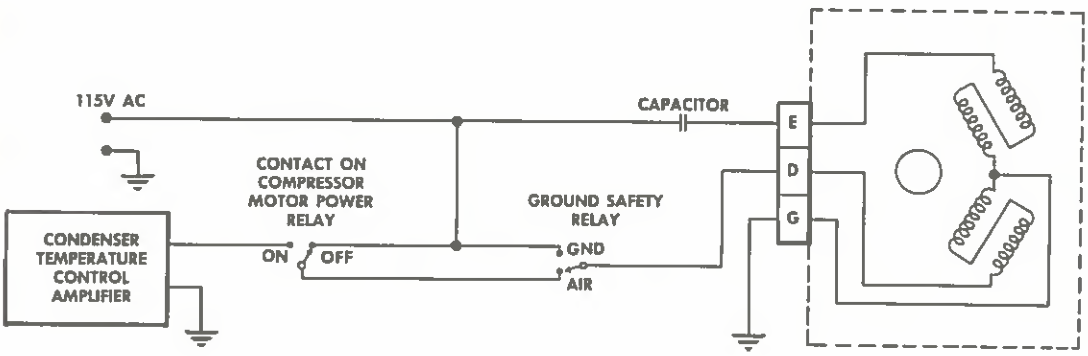
The cooling air modulating valve, shown on Figure 1, is a nine-inch electrically-actuated butterfly valve. The valve has an actuator that contains an electric motor and gear train which is splined to the butterfly valve. The actuator is electrically connected through the landing gear down and locked relay to the Freon compressor motor relay, condenser ground cooling shutoff valve and the condenser minimum temperature control.

2. Operation

Ram air discharge from the Freon condenser during cruising flight is controlled by modulating this valve. At low airspeeds when the landing gear is down and locked, a pressure switch will close the cool air modulating valve, open the ground cooling air shutoff valve, and turn on the condenser fan. Modulation signals originate in the condenser minimum temperature control. The electric motor of the actuator is a servo motor with two phase windings. Motor rotation is caused by a phase difference in voltage applied to the motor windings. Reference voltage is 115-volt, ac power from the condenser temperature control is capacitance coupled to one winding of the valve actuator at all times. Control voltage for valve modulation connects to the opposite winding from the condenser minimum temperature control amplifier through closed contacts of the Freon compressor motor relay and landing gear down and locked relay (in airborne position). If the Freon compressor is turned off or the airplane lands, 115-volts ac power is supplied to the control winding to close the valve. Thus, valve modulation is scheduled only in flight and only when cooling is scheduled provided that the temperature of the condenser discharge air is between 65 degrees F (18.3 degrees C) and 85 degrees F (29.4 degrees C). The valve will start closing when the condenser discharge air temperature reaches 65 degrees F, and will start opening when the air temperature reaches 85 degrees F.







22 30.21.056A

Condenser Cooling Air Modulating Valve
Figure 1

CONDENSER COOLING AIR MODULATING VALVE - MAINTENANCE PRACTICES

1. Removal/Installation Condenser Cooling Air Modulating Valve (see Figure 201)

   A. Equipment Required - None.

   B. Preparation.

      (1) Open Freon package access door (cabin or flight deck).

      (2) Open COND GND COOLING circuit breaker (cabin or flight compartment as required).

      (3) Remove Freon package (refer to 21-3-1, Maintenance Practices).

   C. Remove Condenser Cooling Air Modulating Valve.

      (1) Remove two clamps securing branched duct to shutoff valve and modulating valve at aft edge of Freon package access door, and remove duct. (Tag clamps for installation.)

      (2) Disconnect electrical connector from valve actuator. (Cap connector and receptacle. Tag harness for installation.)

      (3) Remove bolts from connecting flange at aft end of valve.

      (4) Remove valve through the Freon package access door.

   D. Install Condenser Cooling Air Modulating Valve.

      NOTE: Freon package must be removed for access.

      (1) Position valve in airplane with connecting flange aft to mate with discharge duct leading to lower surface of airplane. Valve actuator shall be placed 60 degrees from the top toward the condenser fan.

      (2) Install bolts and nuts in connecting flanges to secure valve to discharge duct; connect bonding jumper from branched duct to valve flange with one of the connecting bolts.

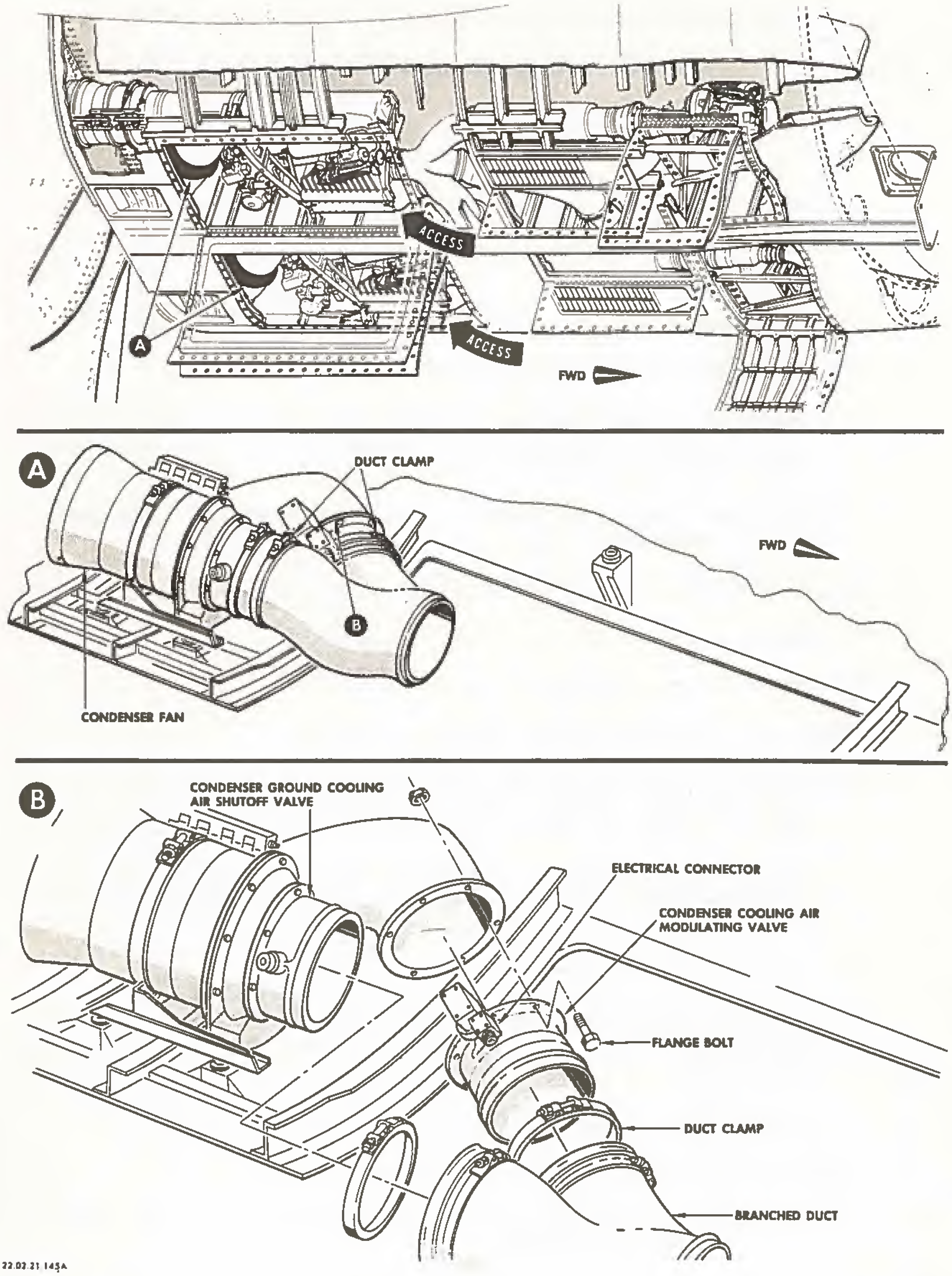
      (3) Connect electrical connector to valve actuator.

      (4) Position branched duct to connect with the condenser outlet, shutoff valve and the modulating valve. Secure in position with three hose clamps.

      (5) Install Freon package (refer to 21-3-1, Maintenance Practices).

      (6) Close COND GND COOLING circuit breaker.

      (7) Perform operational check of the air conditioning system (refer to 21-0, Maintenance Practices).



Condenser Cooling
Air Modulating Valve Installation
Figure 201

2. Cleaning/Painting

A. Clean valve bore and exterior surfaces.

(1) Use a soft lintless cloth moistened with solvent, Specification AMS 3160A to wipe off dirt and grease deposits.

CAUTION: DO NOT IMMERSE VALVE IN CLEANER.

(2) Remove corrosion using a fine crocus cloth.

B. Touch up paint damage when total damage does not exceed five percent of the total painted area. Use black enamel, Specification AMS 3120B, and allow paint to dry at least four hours at room temperature.

3. Approved Repair

A. Repair valve by replacing actuator when required (see Figure 201).

(1) Remove actuator by removing retaining nuts and washers.

(2) Hold new actuator in position over shaft (with receptacle toward valve upstream) and rotate valve disc until shaft splines line up with actuator splines.

CAUTION: DO NOT ROTATE VALVE DISC WHEN ACTUATOR IS INSTALLED ON VALVE.

(3) Connect actuator to valve and secure with retaining washers and nuts.

(4) Check valve performance.

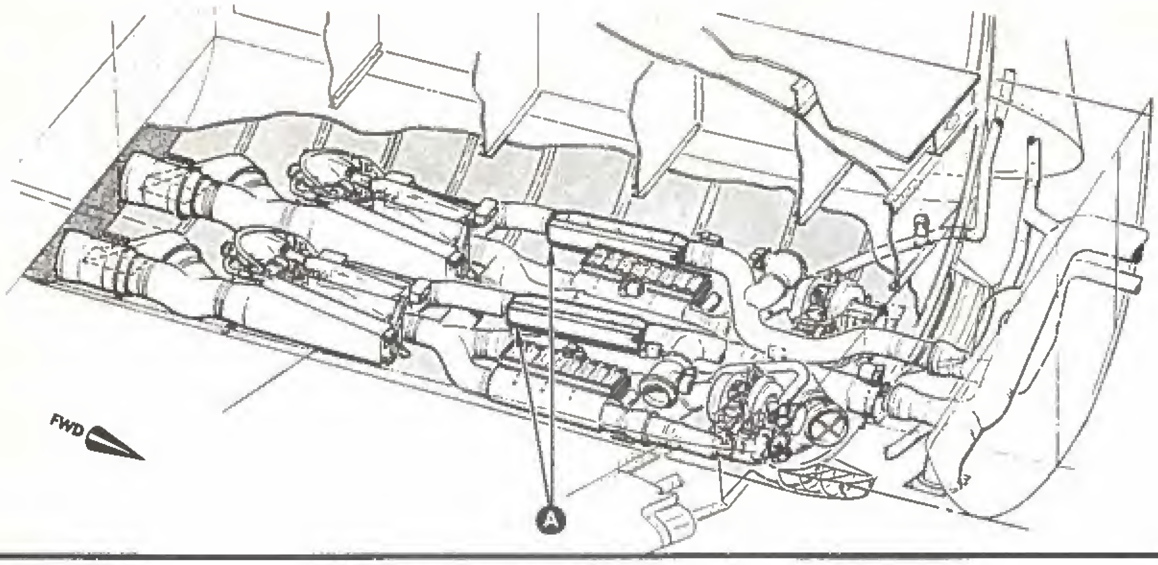
ELECTRIC HEATER - DESCRIPTION AND OPERATION

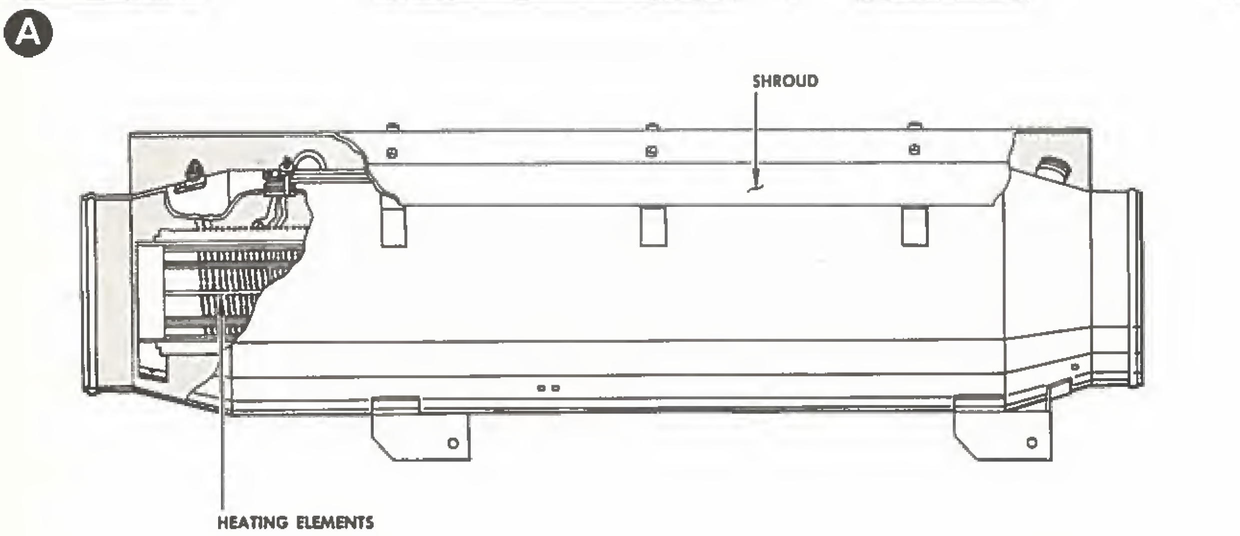
1. Description

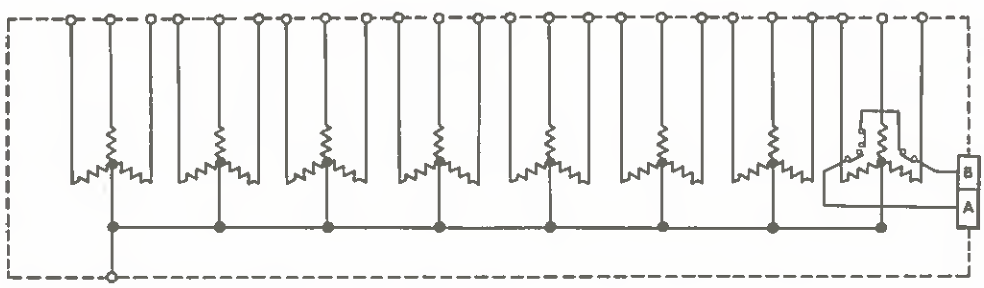
The electric heater, shown on Figure 1, is an expanded section of ducting containing seven heating elements and an overheat switch. The heater terminals are connected to 115/200-volt, 400-cycle, 3 phase, ac power through contacts of the heater relays. The overheat switch consisting of three normally closed contacts in series around the three phases of the first heater element, connects the relay coil to ground through contacts of the recirculation fan motor relay.

2. Operation

The heating elements are relay energized in seven increments to provide modulated heating from zero to full capacity when heating of the recirculated or fresh air is scheduled on airplanes N802TW through N811TW. On airplanes N801TW and N812TW through N830TW, only recirculated cabin air is available for heating. When heating is scheduled, the sequencing device rotates seven cams that actuate respective switches. Each switch as it actuates in turn applies 28-volt dc power from closed contacts of the landing gear ground safety relay (airplane on the ground) through the FREON COMPRESSOR FLT DECK OFF - CABIN ON - BOTH OFF control switch to the coils of respective (1 through 7) heater element relays. When low flow requirements coupled with high scheduled heating cause excessive element heating to 350 degrees F, or if the recirculation fan is turned off, the duct heater will be inoperative since actuating either the thermal switch or fan motor relay will interrupt the 28-volt dc relay ground removing power from the elements. The thermal protective switch will automatically reset when temperatures fall below 350 degrees F.







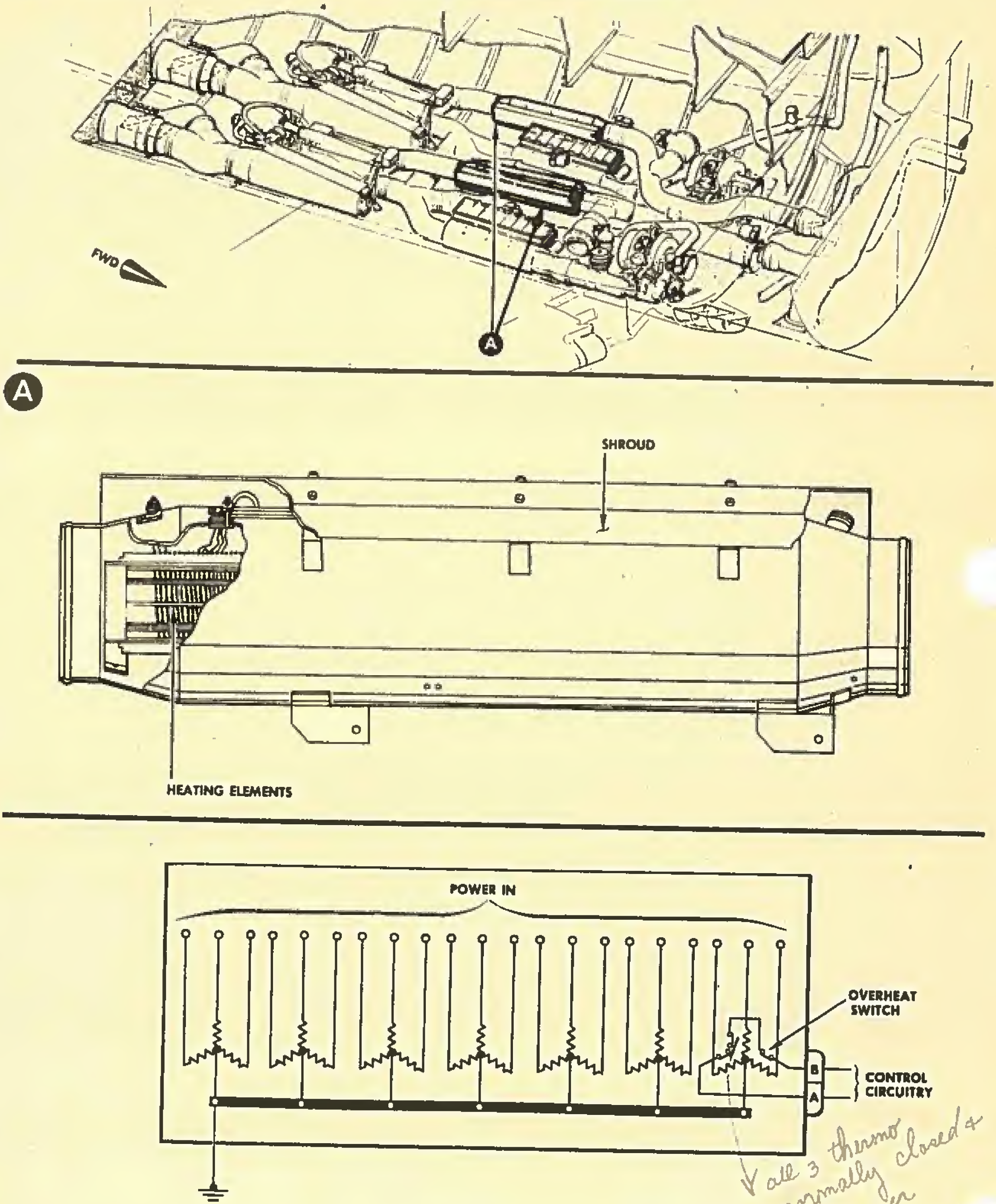
22 30.21.035

Electric Heater
Figure 1

TEMPORARY REVISION NO. 21-22.

Insert facing 21-3-13, Page 2 dated Dec. 5/60.

This illustration replaces the illustration on page 2.



✓ all 3 thermo sw are normally closed & in series A to B per 22.02.21.259.10A 21-4-0 p21

22.33.21.236 B

Electric Heater
Figure 1

ELECTRIC HEATER - MAINTENANCE PRACTICES

1. Removal/Installation Electric Heater (see Figure 201)

   A. Equipment Required - None.

   B. Preparation for Removal of the Cabin Electric Heater.

      (1) Open CABIN HEATER CONT RELAY circuit breaker. Place warning tag on open circuit breaker.

      (2) Remove three 70 ampere FREON COMPR AIR COND HTRS fuses from the No. 2 ESS AC BUS. (Located on the ac power distribution panel below the flight engineer's control panel.)

      WARNING: DO NOT OPEN THE AC POWER DISTRIBUTION PANEL WHEN THE BATTERY IS ON, THE ENGINES ARE RUNNING, OR WHEN EXTERNAL POWER IS CONNECTED TO THE AIRPLANE.

      (3) Open cabin (RH) heat exchanger access door.

   C. Remove Cabin Electric Heater.

      (1) Remove nuts, washers, and bolts from the connecting flanges on both ends of the duct section which bends approximately 45 degrees. Remove the duct section. (Bag and tag hardware for installation.)

      (2) Release snap fasteners and remove insulating cover from heater.

      (3) Disconnect electric connector from thermal switch receptacle near front of heater. (Tag for installation)

      (4) Disconnect heater electrical harness at quick disconnect fitting. Quick disconnect fitting is located on compartment overhead slightly aft and to the right of the heater.

      (5) Remove two clamps securing heater electric harness to compartment overhead.

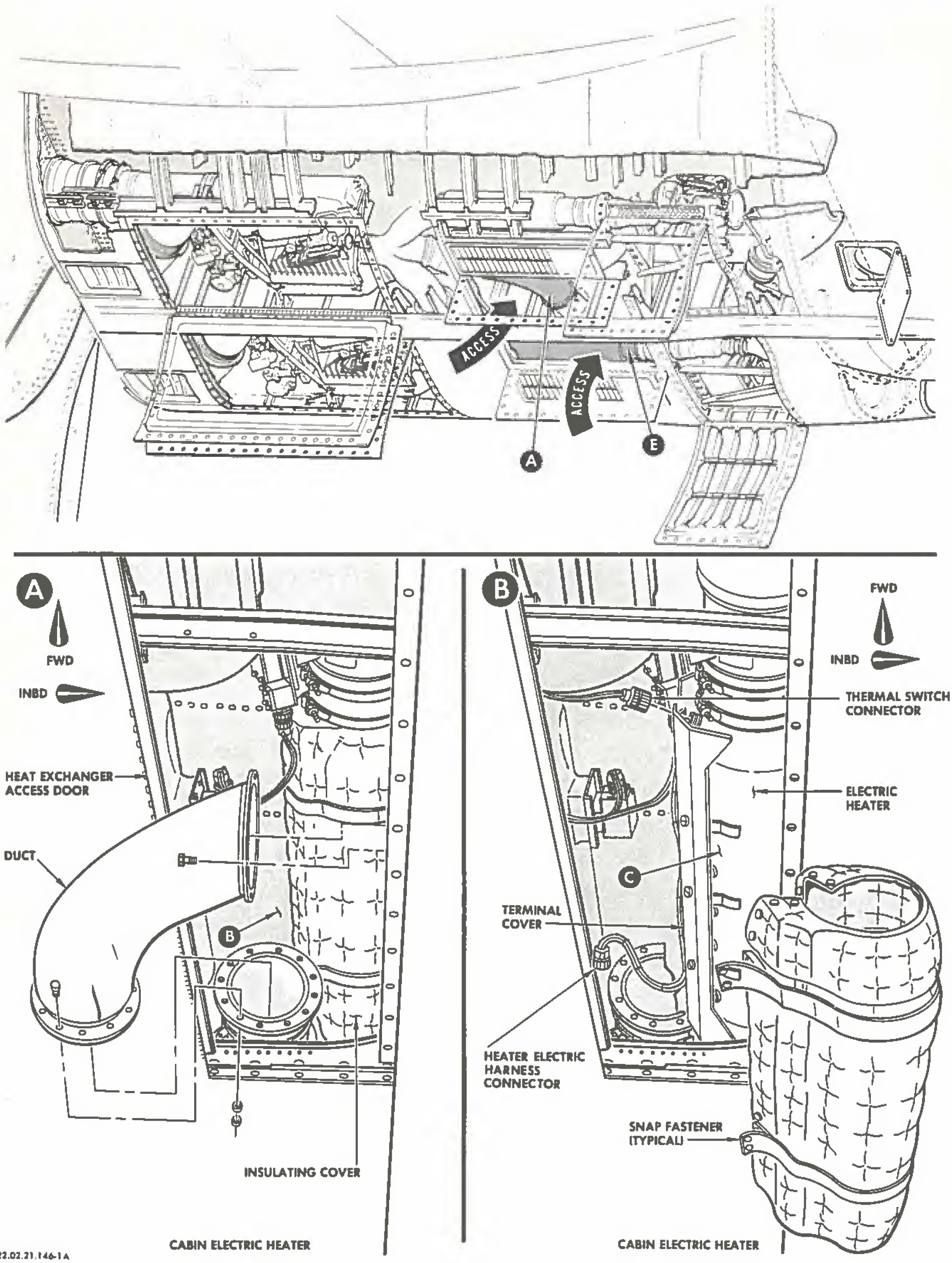
      (6) Release forward and aft duct connections on heater.

      (7) Remove bolts which secure heater mounting brackets to airplane structure. (Support heater while removing last bolt from each bracket.)

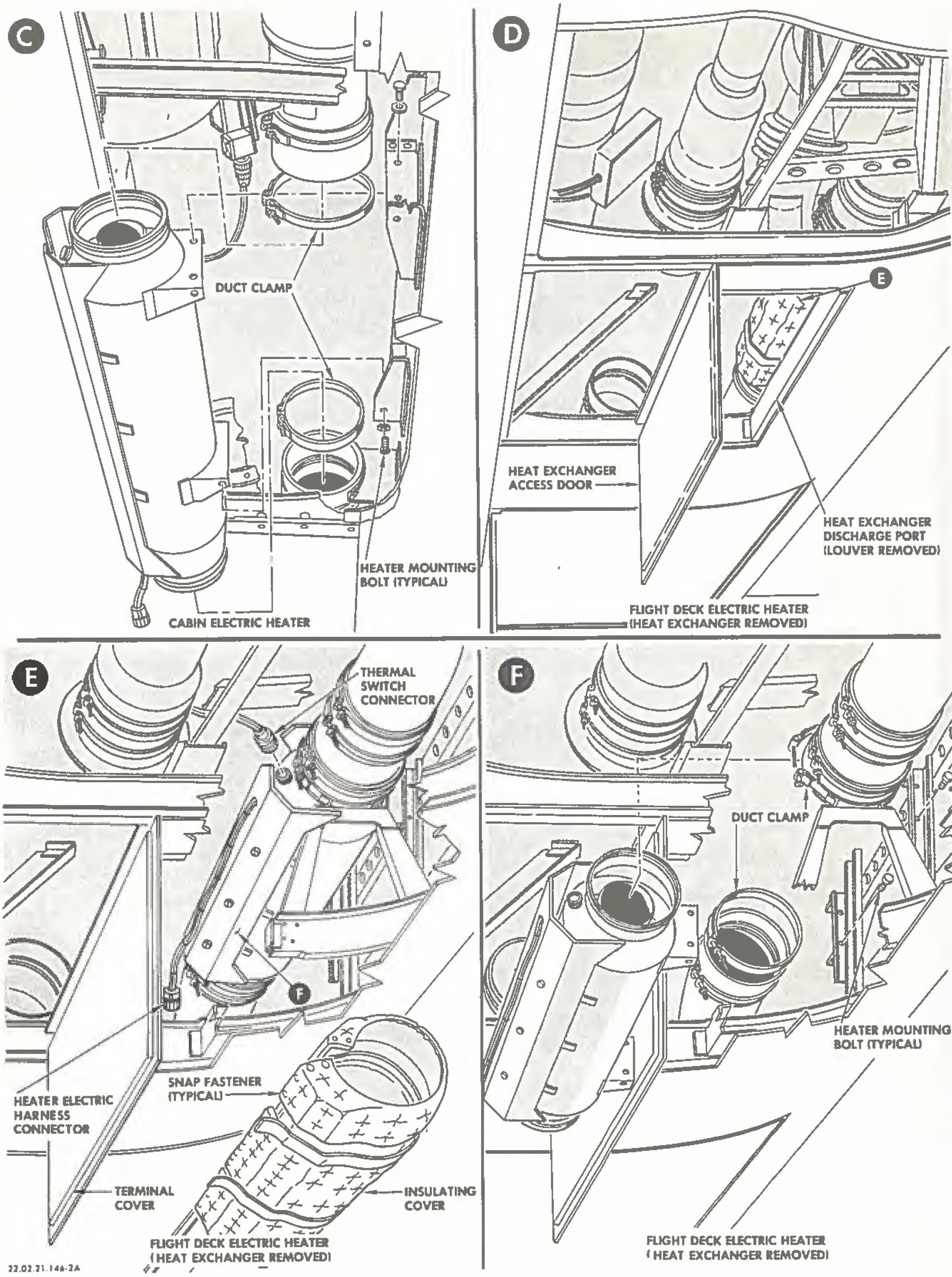
      (8) Remove heater through heat exchanger access door.

   D. Install Cabin Electric Heater.

      (1) Insert cabin electric heater through the right hand heat exchanger access door. Position heater between duct connections with thermal



Electric Heater Installation
Figure 201 (Sheet 1 of 2)



Electric Heater Installation
Figure 201 (Sheet 2 of 2)

switch receptacle forward and terminal cover plate on right hand side.

(2) Install bolts through heater mounting brackets and secure heater to airplane structure.

(3) Connect forward and aft duct connections to heater and secure with clamps.

(4) Connect electrical connector to thermal switch receptacle near front of heater.

(5) Connect heater electrical harness to quick disconnect fitting. Fitting is on compartment overhead slightly aft and to the right of the heater.

(6) Secure heater electrical harness to compartment overhead with two retaining clips.

(7) Install insulating cover around electric heater.

(8) Position duct section which bends approximately 45 degrees, and install gasket, bolts, washers, and nuts in the connecting flanges.

(9) Close heat exchanger access door.

(10) Install three FREON COMPR AIR COND HTRS fuses in the NO. 2 ESS AC BUS. (Ac power distribution panel is below the flight engineer's control panel.)

WARNING: DO NOT OPEN THE AC POWER DISTRIBUTION PANEL WITH THE BATTERY ON, THE ENGINES RUNNING, OR WITH EXTERNAL POWER CONNECTED TO THE AIRPLANE.

(11) Remove warning tag and close the CABIN HEATER CONT RELAY circuit breaker.

(12) Check heater operation by using recirculation fan and manually scheduling heating.

E. Preparation for Removal of Flight Compartment Electric Heater.

(1) Open FLT DECK HEATER CONT RELAY circuit breaker. Place warning tag on open circuit breaker.

(2) Remove three 70 ampere FREON COMPR AIR COND HTRS fuses from the No. 4 NON ESS AC BUS. (Located on the ac power distribution panel below the flight engineer's control panel.)

WARNING: DO NOT OPEN THE AC POWER DISTRIBUTION PANEL WHEN THE BATTERY IS ON, THE ENGINES ARE RUNNING, OR WHEN EXTERNAL POWER IS CONNECTED TO THE AIRPLANE.

(3) Remove flight compartment (LH) heat exchanger (refer to 21-3-2, Maintenance Practices).

F. Remove Flight Compartment Electric Heater.

(1) Release snap fasteners and remove insulating cover from the electric heater.

(2) Disconnect electric connector from thermal switch receptacle near front of heater. (Tag for installation.)

(3) Disconnect heater electrical harness at quick-disconnect fitting. Fitting is located on compartment overhead slightly aft and to the left of the heater.

(4) Remove clamp securing heater electrical harness to compartment overhead.

(5) Release forward and aft duct connections on heater.

(6) Remove bolts which secure heater mounting brackets to airplane structure. (Support heater while removing last bolt from each bracket.)

(7) Remove electric heater through heat exchanger access door.

G. Install Flight Compartment Electric Heater.

(1) Insert flight compartment electric heater through the left hand heat exchanger access door. Position heater between duct connections with thermal switch receptacle forward and terminal cover plate on right hand side.

<u>NOTE:</u> Flight compartment heat exchanger must be removed for installation of flight deck electric heater.

(2) Install bolts through heater mounting brackets and secure heater to airplane structure.

(3) Connect forward and aft duct connections to heater and secure with clamps.

(4) Connect electrical connector to thermal switch receptacle near front of heater.

(5) Install insulating cover around electric heater.

(6) Install flight compartment heat exchanger (refer to 21-3-2, Maintenance Practices).

(7) Close heat exchanger access doors.

(8) Install three 70 ampere FREON COMPR AIR COND HTRS fuses in the NO. 4 NON ESS AC BUS. (Ac power distribution panel below the flight engineer's control panel.)

WARNING: DO NOT OPEN THE AC POWER DISTRIBUTION PANEL WITH THE BATTERY ON, THE ENGINES RUNNING, OR WITH EXTERNAL POWER CONNECTED TO THE AIRPLANE.

(9) Remove warning tag and close the FLT DECK HEATER CONT RELAY circuit breaker.

(10) Check heater operation by using the recirculation fan and manually scheduling heating.

2. Inspection/Check

A. Check external surfaces for damage or wear described.

(1) Examine painted surfaces for damage or wear of the paint.

(2) Check the threads and pins of the electrical receptacle for damage or corrosion.

(3) Check the inlet and outlet for cracks, grooves or scratches that might cause leakage.

(4) Examine all surfaces for exposed metal, corrosion, dents or damage that might impair flow or cause leakage.

3. Cleaning/Painting

A. Clean only the exterior surfaces with a soft lintless cloth moistened with solvent, Specification AMS 3160A to remove dirt and grease deposits.

WARNING: DO NOT IMMERSE HEATER IN SOLVENT OR ALLOW CLEANER TO ENTER THE DUCT, SWITCH OR RECEPTACLE.

B. Touch up damaged paint when damage does not exceed 5 percent of the total painted area. Use black enamel, Specification AMS 3120B and allow paint to dry at least 4 hours at room temperature.

4. Approved Repair

A. Repair of the heater shall be limited to retouching paint, corrosion removal with crocus cloth or removal of slight dents using a leather mallet.

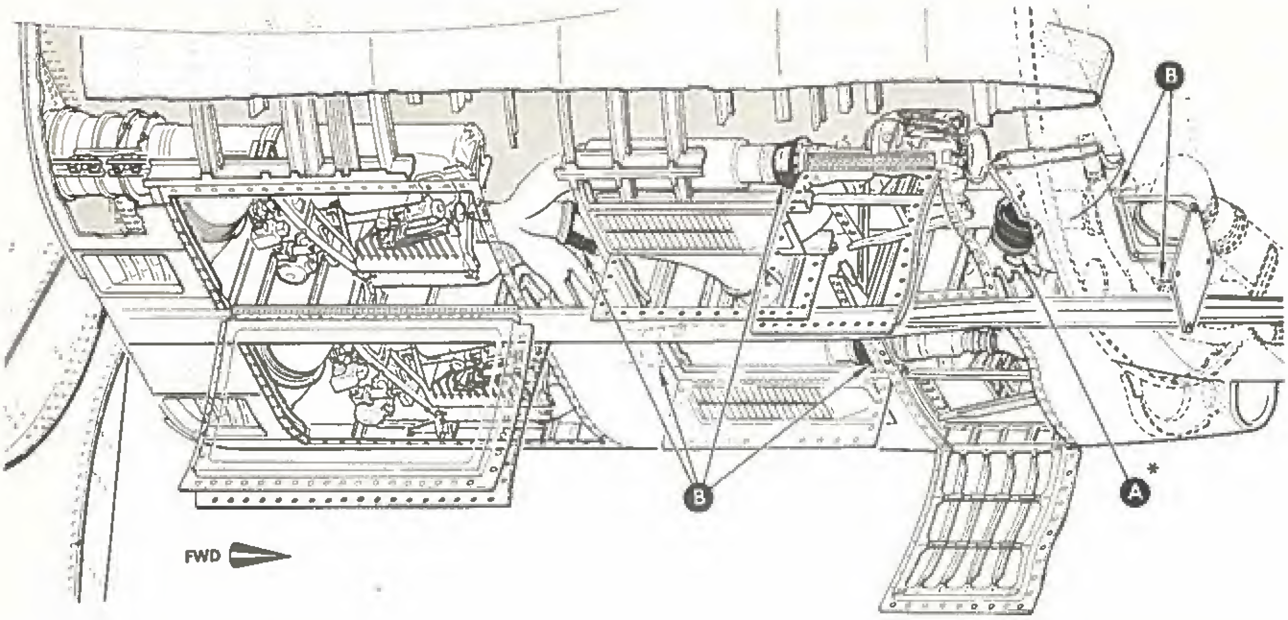
CONDITIONED AIR CHECK VALVE - DESCRIPTION AND OPERATION

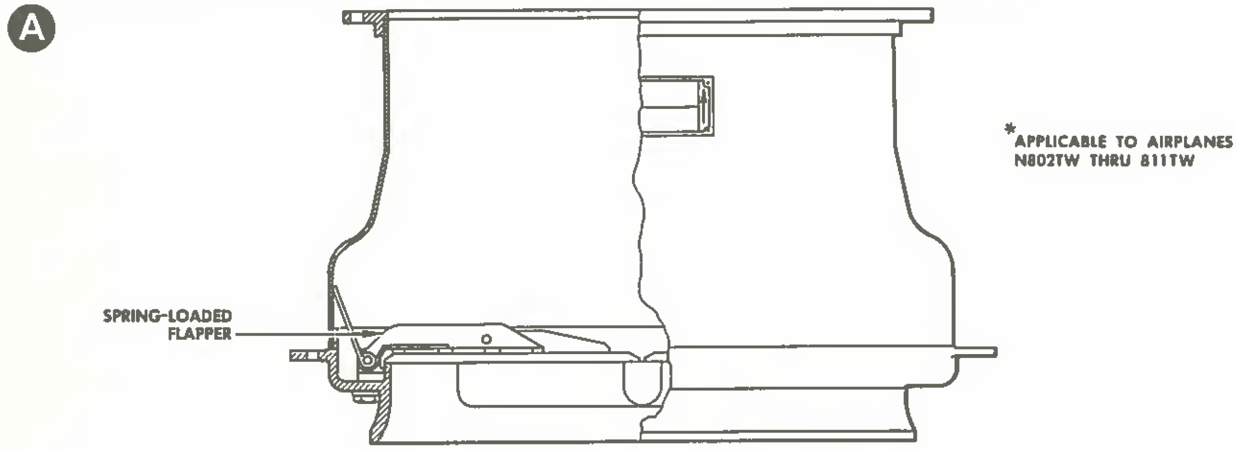
1. Description

The conditioned air check valve consists of a short sheet metal housing containing four flapper valve quadrants. Each flapper valve is lightly held in the closed position by a torsion spring. See Figure 1. The inlet connection has a flange which is bolted to the adjoining duct and the outlet connection contains a bead to secure a hose and clamp type of connection. This arrangement eliminates the possibility of installing a check valve in the wrong direction. The conditioned air check valve, the recirculation air check valve, and the turbocompressor check valve are identical.

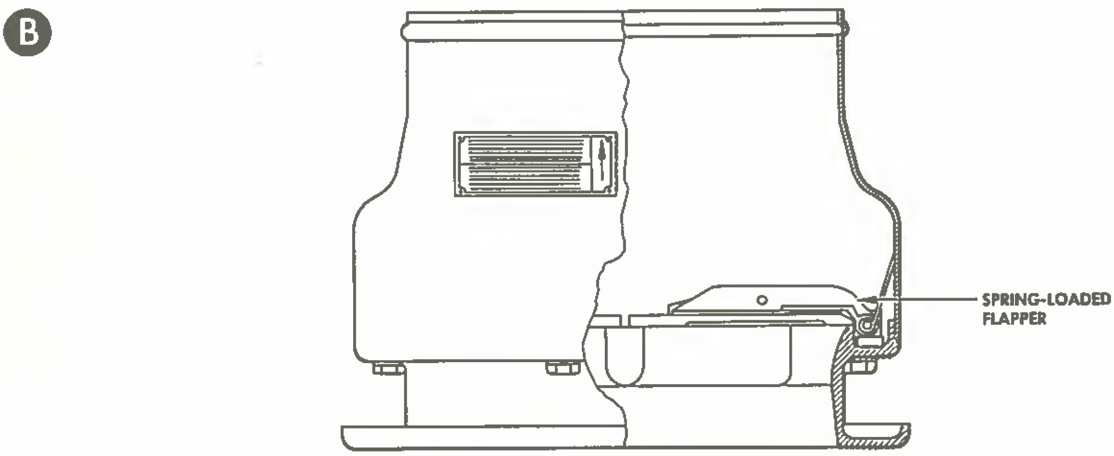
2. Operation

The conditioned air check valve opens to permit the flow of air when the upstream pressure exceeds downstream pressure. Flow in the opposite direction is blocked. The conditioned air check valves are installed between the air conditioning and pressurization system and the pressurized compartments to prevent the loss of pressure if it becomes necessary to shut down one side of the pressurization system. Without the check valve, cabin pressurization might be lost through reverse flow in the air distribution system.





FRESH AIR CHECK VALVE



CONDITIONED AIR, RECIRCULATION AIR, OR TURBOCOMPRESSOR CHECK VALVE

22.30.21.053 A

Air Check Valves
Figure 1

CONDITIONED AIR CHECK VALVE - MAINTENANCE PRACTICES

1. Removal/Installation Conditioned Air Check Valve

   A. Equipment Required - None.

   B. Preparation.

      (1) Open forward cargo compartment door.

      (2) Open zippered lining at aft bulkhead of cargo compartment.

      NOTE: Cabin and Flight Compartment conditioned air check valves are located near floor of compartment against the aft bulkhead. When looking aft, the cabin valve is to the left, and the flight compartment valve is to the right.

   C. Remove the Conditioned Air Check Valve. (Cabin or Flight Compartment.)

      (1) Release aft end of check valve by removing nuts, washers, and bolts from connecting flanges. (Bag and tag for installation.)

      (2) Release forward end of check valve by removing hose clamp. (Tag for installation.)

      (3) Remove check valve and gasket.

   D. Install the Conditioned Air Check Valve. (Cabin or Flight Compartment.)

      (1) With gasket in place, position connecting flange on check valve against connecting flange in conditioned air duct.

      NOTE: Bolt holes in the connecting flanges are not uniformly spaced. Rotate check valve until all mating holes are aligned.

      (2) Install bolts, washers, and nuts to secure valve to duct.

      (3) Install hose and clamp to secure forward end of valve to duct.

      (4) Close zippered lining at aft bulkhead of cargo compartment, and close cargo compartment door.

      (5) Refer to Adjustment/Test for operational check.

2. Adjustment/Test Conditioned Air Check Valve

A. Equipment Required and Preparation.

(1) Test of the conditioned air check valves requires operation of the air conditioning and pressurization system (refer to 21-0, Maintenance Practices).

(2) Place FREON COMPRESSOR ON-OFF switch in OFF position. (Freon compressors not required for this test.)

(3) Place FREON COMPRESSOR FLT DECK OFF-BOTH ON-CABIN OFF switch in BOTH ON position. (Required to close the crossover shutoff valve.)

B. Test Cabin Conditioned Air Check Valve.

(1) Place cabin turbocompressor ON-OFF switch in ON position. A normal cabin air flow indicates that the cabin conditioned air check valve is open.

(2) Place cabin turbocompressor ON-OFF switch in OFF position and flight deck turbocompressor ON-OFF switch in ON position. There shall be no cabin air flow indicated.

NOTE: If cabin air flow is indicated, there are two possible sources. It may indicate reverse flow from a conditioned air check valve that is stuck open, or it may indicate that the crossover shutoff valve is not fully closed. Check visual indicator on crossover shutoff valve. If valve is closed, the conditioned air check valve must be stuck open. If crossover shutoff valve is not fully closed, determine cause and repair as necessary.

(3) After completion of test, shut down system (refer to 21-0, Maintenance Practices).

C. Test Flight Compartment Conditioned Air Check Valve.

(1) Place flight compartment turbocompressor ON-OFF switch in ON position. A normal flight deck air flow indicates that the flight compartment conditioned air check valve is open.

(2) Place flight compartment turbocompressor ON-OFF switch in OFF position and cabin turbocompressor ON-OFF switch in ON position. There shall be no flight compartment air flow indicated.

NOTE: If flight compartment air flow is indicated, there are two possible sources. It may indicate reverse flow from a conditioned air check valve that is stuck open, or it may indicate that the crossover shutoff valve is not fully closed. Check visual indicator on crossover shutoff valve. If valve is closed, the conditioned air check valve must be

stuck open. If crossover shutoff valve is not fully closed, determine cause and repair as necessary.

(3) After completion of test, shut down system (refer to 21-0, Maintenance Practices).

3. Inspection/Check

A. Check valve exterior for the following:

(1) Examine all painted areas for damage to surface treatment.

(2) Check screws that secure flange to valve body for security.

(3) Check flange and bead on valve inlet and outlet for cracks, dents, scratches or other damage that might impair effective sealing.

(4) Check all exposed metal for corrosion.

B. Check all valve interior walls and flappers for the following:

(1) Manually actuate each flapper, checking for binding or excessive load.

(2) Check all internal surfaces for corrosion and for dents, cuts, and obstruction that might impair air flow through valve or prevent sealing of flappers against their seats.

4. Cleaning/Painting

A. Clean and paint valve as follows:

(1) Clean valve using AMS 3160A solvent; rinse and dry thoroughly.

(2) Touch up damaged paint with zinc chromate primer, AMS 3110C, and AMS 3120B black enamel. Allow paint to dry thoroughly (at least four hours) at room temperature.

5. Approved Repair

A. Replace entire valve when damaged, worn, or malfunctioning. Retouch paint damage and remove corrosion. (Use crocus cloth to remove corrosion.)

FRESH AIR CHECK VALVE - DESCRIPTION AND OPERATION
(Applicable to airplanes N802TW through N811TW)

1. Description

The fresh air check valve consists of a short sheet metal housing, approximately 8 inches in diameter, and containing four flapper valve quadrants. Each flapper valve is lightly held in the closed position by a torsion spring. Refer to Section 21-3-14 for an illustration and the location of the fresh air check valve. The inlet opening of the fresh air check valve is exposed to ambient air in the air conditioning compartment. The outlet end has a flange connection which is bolted to the fresh air control valve.

2. Operation

The fresh air check valve opens when the recirculation fan is operated and the fresh air control valve is opened. The fan causes a pressure reduction which allows ambient air to force the flapper segments open, and the air is directed to the cabin and flight deck air conditioning systems. The check valve prevents flow in the opposite direction. The fresh air check valve prevents the loss of cabin pressure via the recirculation control valve when the airplane is pressurized. Without the check valve, pressurized air might escape through the recirculation control valve and the fresh air control valve.

FRESH AIR CHECK VALVE - MAINTENANCE PRACTICES
(Applicable to airplanes N802TW through N811TW)

1. Removal/Installation Fresh Air Check Valve

   A. The fresh air check valve and the fresh air control valve are removed from the airplane as an assembly. After removal, the two components are separated. Refer to Section 21-3-8, FRESH AIR CONTROL VALVE.

2. Inspection/Check

   A. Check all exterior surfaces. They shall be without the damage or wear described.

      (1) Examine all painted areas for damage to the surface treatment.

      (2) Manually check the screws that retain the flange to the valve body for tightness.

      (3) Check the flange for cracks, dents, scratches or other damage that might impair effective sealing.

      (4) Check all exposed metal for corrosion.

      (5) Examine the support ears for damage or wear.

   B. Check the valve interior walls and flappers. Parts shall be free from the damage described.

      (1) Manually actuate each flapper checking for binding or excessive load.

      (2) Check all internal surfaces for corrosion and for dents, cuts and obstruction that might impair air flow through the valve or prevent proper seating of the flappers.

3. Cleaning/Painting

   A. Clean the valve using AMS 3160A solvent, rinse and dry thoroughly.

   B. Retouch damaged paint with AMS 3120B black enamel. Allow the paint to dry thoroughly (at least 4 hours) at room temperature.

RECIRCULATION AIR CHECK VALVE - DESCRIPTION AND OPERATION

1. Description

The recirculation air check valve, shown in 21-3-14, Figure 1, is identical to the conditioned air check valves and the turbocompressor check valves. Refer to 21-3-14, CONDITIONED AIR CHECK VALVE for a description of the valves.

2. Operation

The recirculation air check valve permits air to flow from the recirculation fan, but closes to prevent a reverse flow of air from the turbocompressors to the fan. The check valve also prevents a crossover flow of air between the cabin and flight deck systems in the event one turbocompressor fails or is shut down during flight. Engine bleed air is also prevented from entering the fan housing when the emergency pressurization system is operating.

RECIRCULATION AIR CHECK VALVE - MAINTENANCE PRACTICES

1. Removal/Installation Recirculation Air Check Valve

A. Equipment Required - None.

B. Preparation - Open heat exchanger access door (cabin or flight compartment as required).

C. Remove Cabin Recirculation Air Check Valve.

(1) Release hose clamp aft of recirculation air check valve.

NOTE: If Freon package is not installed, the hose clamp is easier to reach from the Freon package access door.

(2) Remove nuts, washers, and bolts from connecting flange on forward end of duct section which passes through the centerline bulkhead. This duct runs forward from the check valve and bends approximately 45 degrees toward the centerline bulkhead.

(3) Release clamp near aft edge of heat exchanger access door which secures duct section to mounting bracket.

(4) Remove duct section with check valve through heat exchanger access door.

(5) Separate check valve from duct by removing nuts, washers, and bolts from connecting flange.

D. Install Cabin Recirculation Air Check Valve.

(1) Prior to installation in airplane, connect check valve to aft end of duct section which bends approximately 45 degrees toward the centerline bulkhead. Install bolts, washers, and nuts to secure connecting flanges.

(2) Determine that connecting hose and clamps are in position to connect aft end of check valve to crossover duct. Position assembled duct and check valve in airplane so that hose connection aft of check valve and flange connection on forward end of duct are mated to their connections.

(3) Position hose and install clamp to secure aft end of check valve to crossover duct.

NOTE: If Freon package is removed, this step can be accomplished much easier by reaching through the Freon package access door.

(4) Install clamp which secures duct section to mounting bracket near aft edge of heat exchanger access door.

(5) With gasket in place, install bolts, washers, and nuts in connecting flanges at forward end of duct which bends approximately 45 degrees. (Connecting flange is near and parallel to the centerline bulkhead.)

(6) Operate recirculation fan and check for normal air flow indication.

E. Remove Flight Compartment Recirculation Air Check Valve.

(1) Release hose clamp at upper rear connection of branched duct. (Branched duct is next to centerline bulkhead and forward end of duct connects to recirculation fan.)

(2) Release hose clamp at aft end of the flight compartment recirculation air check valve. (Check valve is located about two feet aft of hose clamp released in step (1).

(3) Release clamp which secures duct section to mounting bracket near forward end of check valve.

(4) Remove short straight duct section with check valve attached.

(5) Separate check valve from duct by removing nuts, washers, and bolts from connecting flange.

F. Install Flight Compartment Recirculation Air Check Valve.

(1) Prior to installation in airplane, attach check valve to short straight duct section by installing bolts, washers, and nuts in connecting flanges.

(2) Position assembled valve and duct in airplane with check valve aft. Forward end of duct connects to upper rear connection on branched duct. (Near centerline bulkhead.)

(3) Install hose and clamp on forward end of duct section and at aft end of check valve.

(4) Install clamp to secure duct to mounting bracket forward of check valve.

(5) Close heat exchanger access door.

(6) Operate recirculation fan and check for normal air flow indication.

NOTE: For additional information on recirculation air check valve maintenance practices, refer to 21-3-14, Maintenance Practices.

TURBOCOMPRESSOR CHECK VALVE - DESCRIPTION AND OPERATION

1. Description

The turbocompressor check valve consists of a short sheet metal housing containing four flapper valve quadrants. Each flapper valve is lightly held in the closed position by a torsion spring. Refer to Section 21-3-14, Figure 1. The inlet connection has a flange which is bolted to the adjoining duct, and the outlet connection contains a bead to secure a hose and clamp type of connection. This arrangement eliminates the possibility of installing a check valve in the wrong direction. The turbocompressor check valve, the conditioned air check valve, and the recirculation air check valve are identical.

2. Operation

The turbocompressor check valve opens to permit the flow of air when the upstream pressure exceeds downstream pressure. Flow in the opposite direction is blocked. The turbocompressor check valve is installed to prevent loss of engine bleed air through the turbocompressor when the emergency pressurization system is in operation.

TURBOCOMPRESSOR CHECK VALVE - MAINTENANCE PRACTICES

1. Removal/Installation Turbocompressor Check Valve

   A. Equipment Required - None.

   B. Preparation.

      (1) Remove the cabin or flight compartment turbocompressor package as required (refer to 21-1-0, Maintenance Practices).

   C. Remove the Turbocompressor Check Valve.

      (1) Remove hose clamp at aft end of turbocompressor check valve. (Connects to forward end of heat exchanger.) (Tag for installation.)

      (2) Remove check valve from airplane with short duct section attached.

      (3) Separate check valve from duct by removing nuts, washers, and bolts from connecting flanges. (Bag and tag for installation.)

   D. Install the Turbocompressor Check Valve.

      NOTE: Turbocompressor package must be removed for access.

      (1) Prior to installation in airplane, connect check valve to short, straight duct section which will connect it to the venturi duct of the turbocompressor package. Install bolts, washers, and nuts to secure connecting flanges.

      (2) Position assembled duct and check valve so that aft end of check valve connects with the heat exchanger inlet.

      (3) Position hose and install clamp to secure connection between check valve and heat exchanger.

      (4) Install turbocompressor package (refer to 21-1-0, Maintenance Practices).

      (5) Operate turbocompressor and check for normal air flow indication (refer to 21-0, Maintenance Practices).

   E. For additional information on turbocompressor check valve maintenance practices, refer to 21-3-14, Maintenance Practices.

AIR CONDITIONING CONTROL AND INDICATION - DESCRIPTION AND OPERATION

1. General

The temperature control subsystem maintains the cabin and flight compartments at a desired temperature either through automatic operation of the system, or by manual control through actuation of the switches on the flight engineer's control panel. Separate controls for the flight and cabin compartments permit individual regulation of temperatures for either compartment. A toggle switch permits placing the operation of the system in either the manual or automatic modes. Another switch permits the manual selection of either hot or cold conditioned air. The desired temperature for the cabin and flight compartments is selected by placing their respective temperature selector potentiometer in the desired position. Actual compartment temperatures, sensed by thermal resistors, are compared to the selected compartment temperature. The difference between the selected and the actual compartment temperatures causes the electronic temperature control to actuate the sequencing device. The sequencing device regulates the components of the air conditioning subsystem to provide either heating or cooling as required.

In addition to these controls, a separate group of switches and indicators is available to control and monitor the Freon refrigeration subsystem. The group consists of a Freon ON-OFF switch, a Freon compressor FLT DECK OFF-BOTH ON - CABIN OFF control switch, RECIRCULATING BLOWER ON-OFF switch, ram air source OPEN-CLOSE switch, malfunction lights for both Freon systems, and a cabin temperature indicator. A separate ON-OFF switch is available for the electronic compartment cooling fan. An electric schematic of the air conditioning subsystem is illustrated on Figure 1.

2. Temperature Control Operation (applicable to airplanes N802TW through N811TW)

When the temperature selector is positioned to increase or decrease the temperature of the conditioned air an error signal is obtained by the comparison of signals from the compartment and duct thermal resistors and the temperature selector. This error signal causes the electronic temperature control to position the sequencing device so as to schedule the operation of the heat control modulating valve, heat exchanger cool air modulating valve, recirculation control valve, fresh air control valve, electric heater, and back pressure regulating valve. The components regulated by the sequencing device provide for the proper amount of heating or cooling to maintain compartment air temperature at the selected level. The scheduling provided during inflight and ground operation is obtained by dividing the sequencing device travel into four quadrants. Travel of the sequencing device through a particular quadrant results in the correlated operation of a valve or item related to that quadrant. See Figure 2 for a block diagram of the temperature control subsystem and scheduling.

3. Temperature Control Operation (applicable to airplanes N801TW and N812TW through N830TW)

Temperature control operation is essentially the same as described in paragraph 2 with the exception of the fresh air and recirculation control valves. In this configuration the fresh air valves have been deleted, and the recirculation valve functions independently of the temperature control system. The recirculation control valve operates in conjunction with the recirculating fan and is controlled by the RECIRCULATING BLOWER switch.

4. In-flight Scheduling Operation

Travel of the sequencing device through the first quadrant (see Figure 2) results in maximum cooling with the heat exchanger cool air modulating valve and the back pressure regulator valve in the open position, and the heat control modulating valve in the closed position.

Travel through the second quadrant of the sequencing device results in reduction of the Freon refrigeration system's capacity for cooling by progressively restricting Freon flow through the back pressure regulating valve by modulating the valve until it is in the closed position.

Travel through the third quadrant of the sequencing device results in a reduction of cooling of the pressurized air flowing through the heat exchanger by progressively restricting the flow of cooling ram air through the heat exchanger. This is accomplished by gradually modulating the heat exchanger cool air modulating valve to the closed position.

Travel through the fourth quadrant results in increased heating of the pressurized air by the turbocompressor, from a minimum at the beginning of the fourth quadrant to maximum at the end of the fourth quadrant, by gradually modulating the heat control modulating valve to the full open position.

5. Ground Scheduling Operation (Applicable to airplanes N802TW through N811TW)

Travel of the sequencing device through the first quadrant (see Figure 2) results in a reduction of system cooling by gradually closing the recirculation control valve and gradually opening the fresh air control valve.

NOTE: When the temperature control subsystem is calling for maximum cooling (sequencing device at the start of the first quadrant) the recirculation control valve is open and the fresh air control valve is closed because the recirculated cabin air is cooler than the ambient or plenum chamber air.

Travel through the second quadrant of the sequencing device results in a reduction of the Freon refrigeration subsystem capacity by progressively closing the back pressure regulator valve. Travel through the third quadrant results in an increase of heated conditioned air by energizing the elements of the electric heater in seven progressive steps as travel progresses toward the fourth quadrant. Travel through the fourth quadrant results in the termination of fresh air through the fresh air control valve

TEMPORARY REVISION NO. 21-23.

Insert facing 21-4-0, Page 5 dated May 25/61.

This temporary revision is applicable to airplanes after incorporation of Service Bulletin 21-32.

21-4-0, Page 5 dated May 25/61 is applicable prior to incorporation of Service Bulletin 21-32.

Page 5; at lower left corner of art, change LANDING GEAR DOWN AND LOCKED RELAY NO. 2 to RH CONDENSER COOLING CONTROL RELAY.

TEMPORARY REVISION NO. 21-24.

Insert facing 21-4-0, Page 9 dated May 25/61.

This temporary revision is applicable to airplanes after incorporation of Service Bulletin 21-32.

21-4-0, Page 9 dated May 25/61 is applicable prior to incorporation of Service Bulletin 21-32.

Page 9; at lower left corner of art, change LANDING GEAR DOWN AND LOCKED RELAY to CONDENSER COOLING CONTROL RELAY.

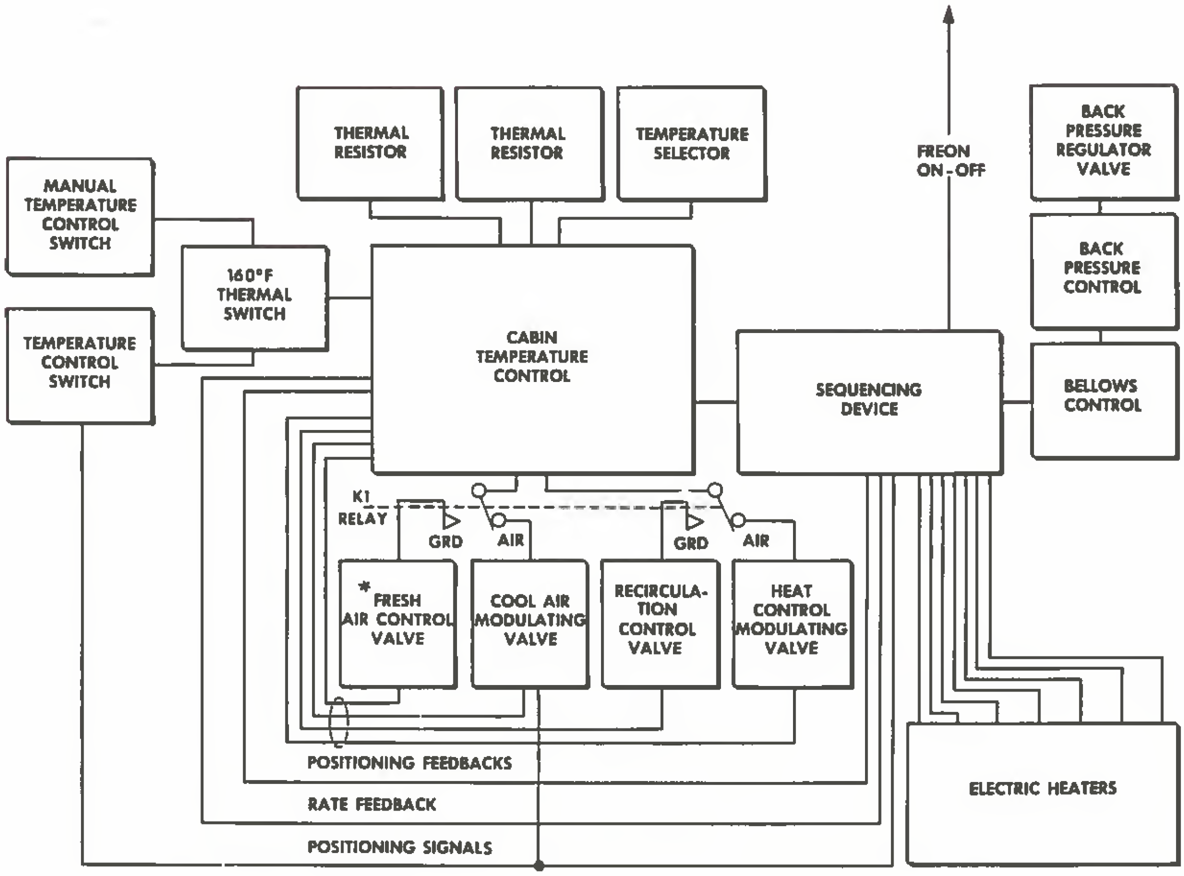
TEMPORARY REVISION NO. 21-25.

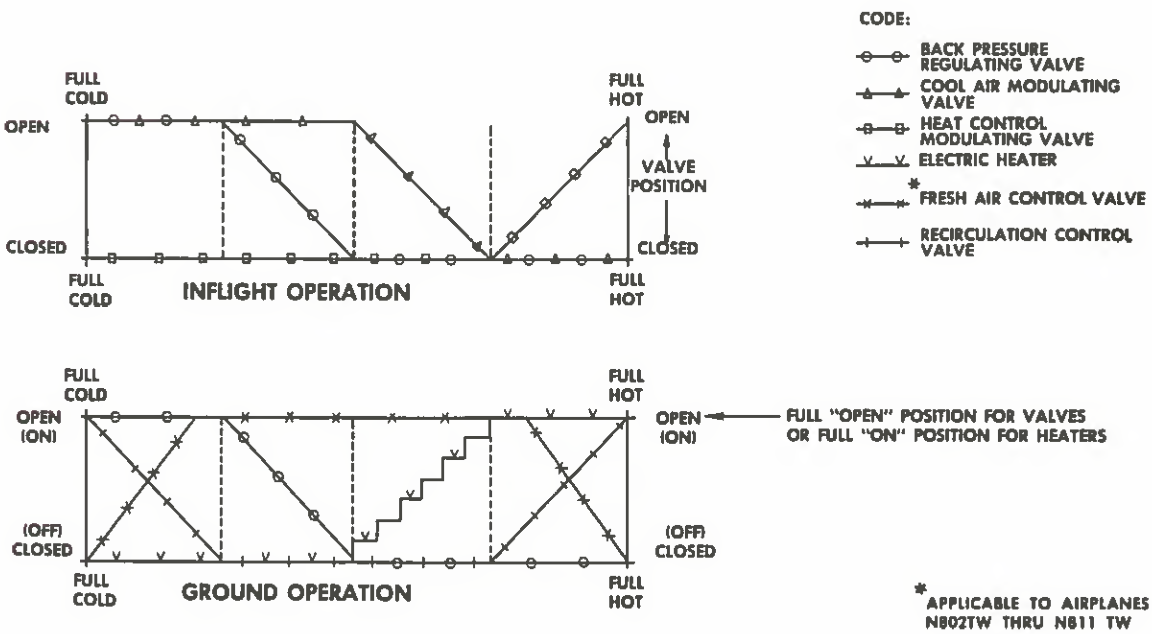
Insert facing 21-4-0, Page 17 dated May 25/61.

This temporary revision is applicable to airplanes after incorporation of Service Bulletin 21-32.

21-4-0, Page 17 dated May 25/61 is applicable prior to incorporation of Service Bulletin 21-32.

Page 17; delete LH LANDING GEAR DOWN AND LOCKED SWITCH from circuit. Connect pin A on CONDENSER COOLING AIR CUT-OFF SWITCH to wire previously connected to pin K on removed down and lock switch. Change LANDING GEAR DOWN AND LOCKED RELAY NO. 1 to LH CONDENSER COOLING CONTROL RELAY.


THERMAL RESISTOR
THERMAL RESISTOR
TEMPERATURE SELECTOR
FREON ON - OFF
BACK PRESSURE REGULATOR VALVE
BACK PRESSURE CONTROL
BELLOWS CONTROL
MANUAL TEMPERATURE CONTROL SWITCH
160°F THERMAL SWITCH
TEMPERATURE CONTROL SWITCH
CABIN TEMPERATURE CONTROL
SEQUENCING DEVICE
K1 RELAY
GRD
AIR
GRD
AIR
* FRESH AIR CONTROL VALVE
COOL AIR MODULATING VALVE
RECIRCULATION CONTROL VALVE
HEAT CONTROL MODULATING VALVE
ELECTRIC HEATERS
POSITIONING FEEDBACKS
RATE FEEDBACK
POSITIONING SIGNALS


FULL COLD
FULL HOT
OPEN
CLOSED
VALVE POSITION
FULL COLD
FULL HOT
INFLIGHT OPERATION
CODE:
BACK PRESSURE REGULATING VALVE
COOL AIR MODULATING VALVE
HEAT CONTROL MODULATING VALVE
ELECTRIC HEATER
* FRESH AIR CONTROL VALVE
RECIRCULATION CONTROL VALVE
FULL COLD
FULL HOT
OPEN (ON)
(OFF) CLOSED
OPEN (ON)
(OFF) CLOSED
FULL "OPEN" POSITION FOR VALVES OR FULL "ON" POSITION FOR HEATERS
FULL COLD
FULL HOT
GROUND OPERATION
* APPLICABLE TO AIRPLANES N802TW THRU N811 TW

22 30.21 012 D

and an increase of recirculation air through the recirculation control. In this case the recirculated cabin air is warmer than ambient or plenum chamber air.

6. Ground Scheduling Operation (Applicable to airplanes N801TW and N812TW through N830TW)

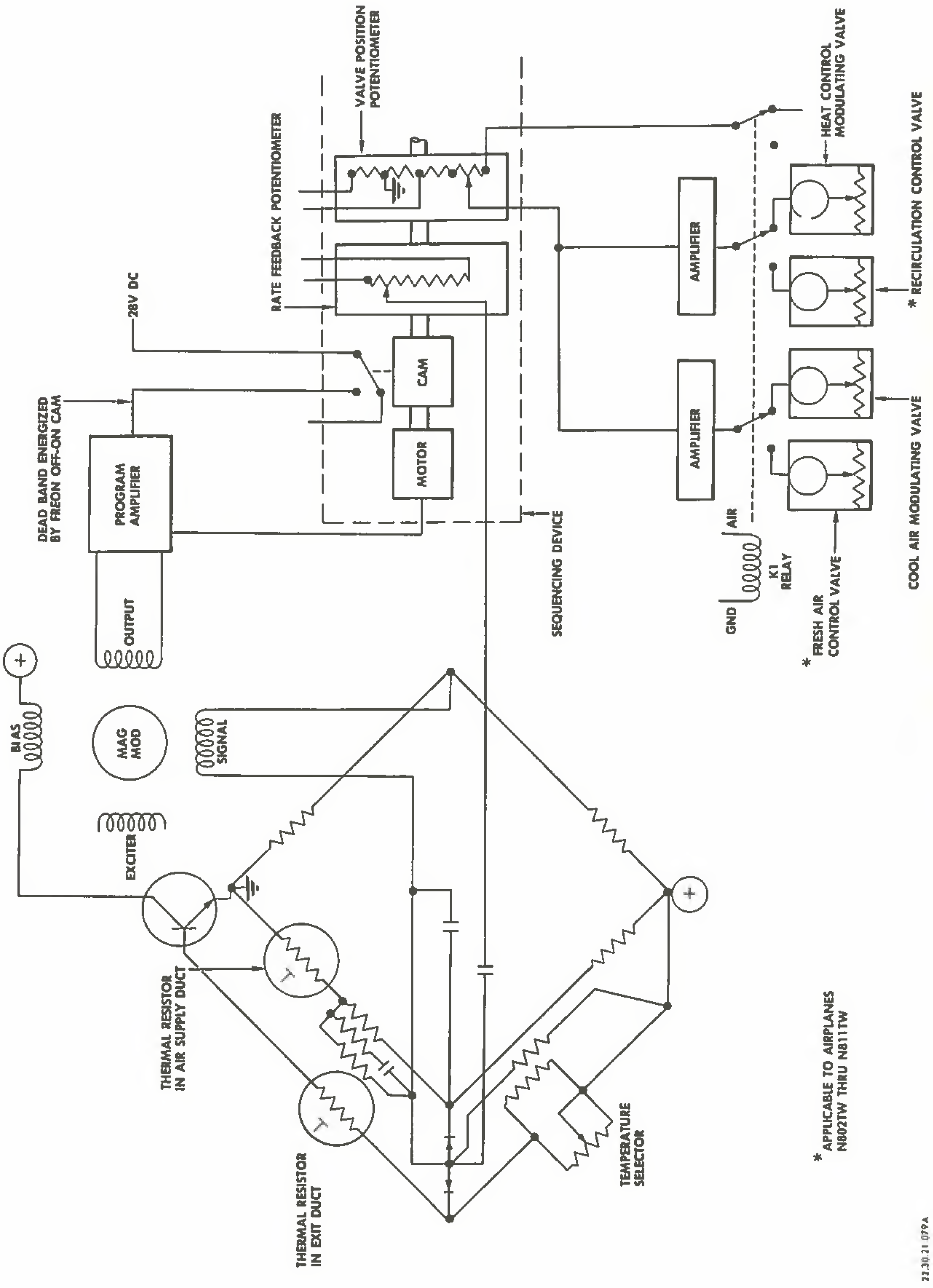
Travel of the sequencing device through the first quadrant has the same results as the first quadrant travel during Inflight Scheduling Operations. Travel through the second quadrant of the sequencing device results in a reduction of cooling by progressively closing the back pressure regulating valve. Travel through the third quadrant results in an increase of heated conditioned air by energizing the heater elements in seven progressive steps as travel progresses toward the fourth quadrant. Travel through the fourth quadrant is a continuation of heating as programmed at the end of the third quadrant travel.

7. Sequencing Device Positioning

Positioning of the sequencing device in one of the four quadrants during automatic operation is controlled by the temperature control. A control voltage, of the proper phase and amplitude from the temperature control to rotate the sequencing device, is obtained from the bridge circuit formed by the thermal resistors, temperature selector, and the temperature control. The temperature of the compartment air is sensed by a thermal resistor located in an air exit duct. The temperature of the conditioned air supplied to the compartment is sensed by a thermal resistor located in a compartment air supply duct. The thermal resistors are connected to the temperature control where they form two bridge circuits (see Figure 3) - one for compartment temperature error and the other for duct temperature limit. The compartment temperature bridge circuit consists of its thermal resistor and the temperature selector, plus suitable balancing fixed resistors. The duct temperature limit bridge consists of its thermal resistor and a preset voltage divider network.

Any signal from the bridge summing point is applied to the signal winding of the magnetic modulator. The bridge circuit is so arranged that current flow through the magnetic modulator signal coil may be in either direction. Thus, a requirement for cooling unbalances the bridge and current flows through the modulator signal coil in a given direction. The requirement for heating causes current flow through the coil in the opposite direction.

Three additional signals are also coupled to this current flow caused by unbalance of the bridge. The additional signals are (1) voltage proportional to the rate of change of duct temperature provided by the supply duct thermal resistor, (2) a voltage proportional to the rate of change of the sequencing device motor and (3) a proportional voltage created by the difference in temperatures sensed by the compartment and duct thermal resistors. These signals are coupled to the signal coil of the magnetic modulator to provide the required compensation for stability. The rate of change of voltage from the sequencing device rate feedback potentiometer is only applicable when the sequencing device is rotating. Once rotation has



Temperature Control Operation
Figure 3

started, the rate of change voltage from the potentiometer reduces the initial starting signal to the sequencing device motor to keep rotation at a slow rate. The rate of change voltage from the supply duct thermal resistor functions in a similar manner in that this voltage is only made available when duct temperatures start changing. Once duct temperature starts changing, the duct rate of change voltage is induced into the signal to the sequencing device motor to maintain a predetermined rate of change of supply duct air temperature. This rate of change of air temperature is maintained regardless of the sensitivity of the particular subsystem that is being used to change duct temperature. The proportional voltage applied to the magnetic modulator provides a 10:1 inverse ratio between sensed compartment and duct temperatures. Each 10-degree increase in duct temperature above the selected setting results in a sensing decrease of 1 degree by the compartment sensor. Conversely, each 10-degree decrease in duct temperature below the setting results in a sensing increase of 1 degree by the compartment sensor. This proportional sensing maintains the cabin or flight compartment at the selected temperature.

8. Magnetic Modulator Functions

The function of the magnetic modulator is to provide an ac voltage signal of the proper phase and amplitude to rotate the sequencing device motor in the desired direction at the desired speed. An excitation ac voltage is supplied to the modulator by means of an exciter coil. The excitation ac voltage is induced into the output winding of the modulator when the modulator is properly biased and supplied with a dc signal voltage. The dc current flow through the bias coil provides a null point above ground at which point the ac output from the magnetic modulator is zero. Varying the polarity of the dc signal current either plus or minus from the bridge circuits signal will vary the ac output voltage so that it is in phase or 180 degrees out of phase with the excitation voltage. Thus, the direction and amount of current flow through the signal winding will determine the phase and amplitude of the voltage from the output winding of the magnetic modulator.

A. Signal Amplification.

The output signal from the magnetic modulator is amplified by a two stage push-pull transistor amplifier. NPN type transistors are used for the first stage and PNP type are used for the second stage. Circuit application of the transistors in both stages is "common emitter." The input signal is applied between base and emitter and the output generated between collector and emitter. Dead band operation, necessary to avoid electric heater fluctuation, is provided by applying 28-volts dc to the base of the second stage transistors. This voltage is applied whenever duct heater operation is scheduled. The 28-volt dc power applied to the base of the transistors reduces the amplification factor of the amplifier resulting in reduced sensitivity of the system.

B. Output.

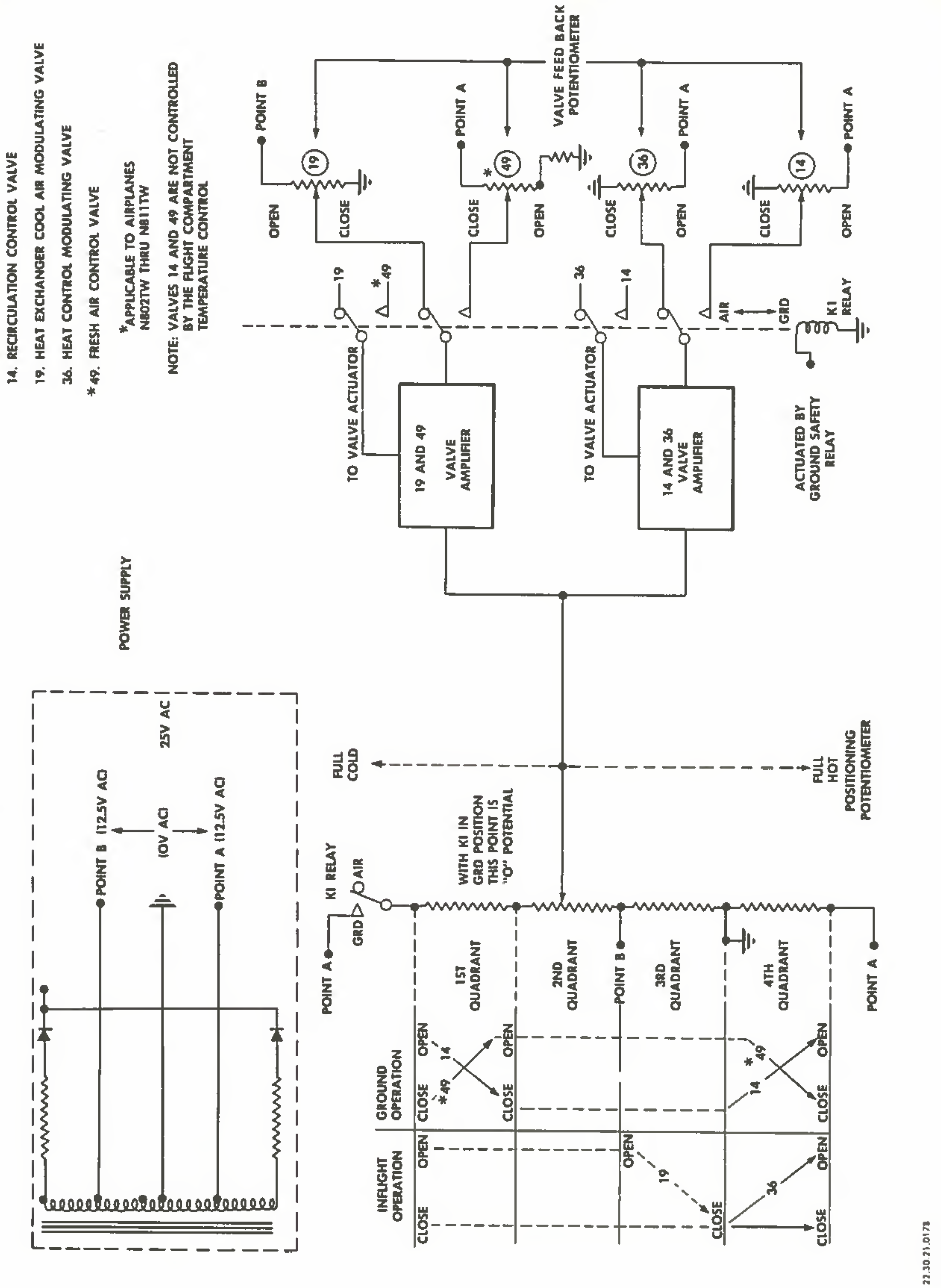
The output from the amplifier is applied to the motor of the sequencing device to provide scheduling as signaled by the error voltage between the thermal resistor and the temperature selector. If the error voltage is small the resultant amplifier voltage to the sequencing device motor is small and the motor rotates slowly. Conversely if the error signal is large the resultant amplifier voltage to the sequencing device will be large and the motor rotates faster.

9. Sequencing Device Scheduling (Applicable to airplanes N802TW through N811TW)

The electric motor of the sequencing device drives the cam shaft through its arc of travel. Operating from the cam shaft are various switches, cams and potentiometers that are activated in the proper sequence as the shaft rotates. The bellows control, Freon switch and electric heater switches are operated by cams on the sequencing device shaft. The rate feedback and positioning potentiometers are geared to the shaft. The positioning potentiometer provides the means of operating, as scheduled, the recirculation control valve, the heat exchanger cool air modulating valve, heat control modulating valve and the fresh air control valve. The wiper of the positioning potentiometer is geared to traverse four quadrants of differential ac voltages. The differential voltages are supplied to the terminals of the potentiometer which form the quadrants (see Figure 4). The four valves controlled by the positioning potentiometer are each equipped with a position feedback potentiometer. The terminals of these valve feedback potentiometers are supplied with the same differential ac voltages as the positioning potentiometer. Thus, each valve feedback potentiometer carries a different ac voltage which corresponds to that voltage found in a particular quadrant of the sequencing device positioning potentiometer. When the positioning potentiometer wiper senses a particular differential voltage in a quadrant, the valve which has the same differential voltage at its feedback potentiometer, is modulated.

Modulation of the valve is accomplished by the difference between the relative positions of the positioning potentiometer wiper and the valve feedback potentiometer wiper. Both wipers are series connected through a primary winding of a signal transformer in the valve amplifier. The voltage sensed by the positioning potentiometer wiper is compared to the voltage sensed by the valve feedback potentiometer wiper. When the potentiometers are at different relative voltage positions, the error voltage between them causes an ac error signal. The error voltage will have a leading or lagging phase depending on the positions of the respective wipers.

The error voltage in the primary of the signal transformer induces an ac voltage to the input of the two stage transistor valve amplifier. The resulting amplified signal is then applied to the valve actuator motor. In response to this signal, the motor will drive the valve and its feedback



Positioning Potentiometer Schematic
Figure 4

potentiometer. The rate and direction of valve travel will be determined by the magnitude and phase of the error voltage. Valve travel will continue until the relative position of the feedback potentiometer corresponds to that of the positioning potentiometer or until the valve positions against its stops.

10. Sequencing Device Scheduling (Applicable to airplanes N801TW and N812TW through N830TW)

Sequencing device scheduling is essentially the same as described in the preceding paragraph with the exception of the fresh air and recirculation control valves. In this configuration the fresh air control valves have been deleted and the recirculation valve is controlled by the RECIRCULATING BLOWER switch independent of the sequencing device.

11. Valve Scheduling (Applicable to airplanes N802TW through N811TW)

The scheduling of the recirculation control valve, the heat exchanger cool air modulating valve, the heat control modulating valve, and the fresh air control valve is as shown in Figure 4. Two ac voltages are supplied from the power supply for positioning purposes. They are 12.5-volt ac between system ground and point A at a given phase, and 12.5-volt ac between system ground and point B at opposite phase from that voltage at point A. These two voltages are applied to the terminals of the positioning and feedback potentiometers to provide the differential voltage. During flight, the K1 relay is in the "air" position and the point A voltage at the "full cold" end of the positioning potentiometer is interrupted. This provides for point B voltage across the first two quadrants. The recirculation control valve and the fresh air control valve are closed and disconnected from their respective amplifiers by the K1 relay. The heat exchanger cool air modulating valve and the heat control modulating valve are subject to positioning control as follows:

A. The cool air modulating valve has point B voltage at the "open" end and ground or zero voltage at the "close" end of its feedback potentiometer. The cool air modulating valve is held open by point A voltage while the positioning potentiometer wiper traverses its first two quadrants. The cool air modulating valve is closed as the positioning potentiometer traverses the third quadrant and going from point B voltage to zero voltage. The valve is held closed through the fourth quadrant by point A voltage which is of opposite phase from that on the cool air modulating valve feedback potentiometer.

B. The heat control modulating valve has point A voltage at the "open" end and ground or zero voltage at the "close" end of its feedback potentiometer. The heat control modulating valve remains closed through the first three quadrants of positioning wiper travel. This is due to point B voltage which is of opposite phase from the point A voltage on the valve feedback potentiometer. The valve opens as the fourth quadrant is traversed due to the point A voltage on the wipers of both potentiometers.

During ground operation, the K1 relay is in the "ground" position. Point A voltage is applied to the "full cold" end of the positioning potentiometer. This point A voltage at the "full cold" end and the point B voltage which exists between the second and third quadrants, effectively provides zero potential between the first and second quadrants. The cool air modulating valve and the heat control modulating valve are closed and disconnected from their respective amplifiers. The recirculation control valve and the fresh air control valve are subject to positioning control as follows:

NOTE: Control of the recirculation control valve and the fresh air control valve is provided by the cabin electronic temperature controller only. The heat exchanger cool air modulating valve and the heat control modulating valve in the flight compartment system are connected to the flight deck electronic temperature control amplifier during both air and ground operations.

The recirculation control valve and the fresh air control valve both have point A voltage at their feedback potentiometers. However, point A voltage is at the "open" position for the recirculation control valve and the "close" position for the fresh air control valve. The valves modulate inversely. As the first quadrant is traversed by the positioning potentiometer wiper the recirculation control valve and the fresh air control valve modulate. The fresh air control valve opens and the recirculation control valve closes. Both valves maintain these positions through the second and third quadrants due to existing point B voltage which is of opposite phase from that of their feedback potentiometers. The valves again modulate as the fourth quadrant is traversed, one closing and the other opening. A resistor in series with the ground end of the fresh air control valve feedback potentiometer provides for valve contouring. The valve attains its full open position when the positioning potentiometer wiper senses approximately 35 percent point A voltage above ground.

12. Valve Scheduling (Applicable to airplanes N801TW and N812TW through N830TW)

Valve scheduling is essentially the same as described in the preceding paragraph with the exception of the fresh air and recirculation control valves. In this configuration the fresh air control valves have been deleted and the recirculation valve is controlled by the RECIRCULATING BLOWER switch independent of the sequencing device and electronic temperature controller.

13. Air Conditioning Subsystem Switch Functions

A system of switches, or switching actions, is utilized to effectively operate both the cabin and flight compartment air conditioning and turbocompressor units. Various switches control the operation of both units; the remaining switches are paired so that each provides the same type control to its particular units as the other. The switches are as follows (refer to 21-2-0, Figure 2 for an illustration of the control panel.):

Freon Compressor ON-OFF Switch

Freon Compressor FLT DECK OFF-BOTH ON-CABIN OFF Switch

Ram Air Source OPEN-CLOSE Switch

Turbocompressor ON-OFF Switches

Ground Safety Relays (Actuated by ground safety switches on Main Landing Gear)

Temperature Control AUTO-OFF-MAN Switches

Temperature Control MAN HOT-MAN COLD Switches

Recirculating Blower ON-OFF Switch

Reset Switches

Electric Heater Thermal Switches

Reverse Thrust Switch

Turbocompressor Overspeed Switch

Landing Gear Down and Locked Relay

160°F Thermal, Switch

The type and function of each of these switches is as follows:

14. Freon Compressor ON-OFF Switch

The Freon compressor ON-OFF switch is a single-pole, double-throw switch which provides on-off operation for both the cabin and flight compartment Freon systems. When placed in the OFF position, electrical power is terminated to the respective on-off micro-switches in the sequencing devices to prevent operation of the Freon condenser fan and compressor and to shut down the Freon system. When the switch is placed in the ON position, electrical power is available so that the Freon system can operate whenever Freon operation is scheduled by the sequencing device.

15. Freon Compressor FLT DECK OFF-BOTH ON-CABIN OFF Switch

The FLT DECK OFF - BOTH ON - CABIN OFF control switch is a three-position, multiunit microswitch which provides control of both the cabin and flight compartment Freon systems. When placed in the BOTH ON position (center position) it performs the following functions:

A. Connects the sequencing device amplifier in the electronic temperature control to the temperature control AUTO-OFF-MAN switch. The signal is then available for automatic operation of the sequencing device.

B. Applies 115-volt ac power through the control switch "on" contacts to the "open" side of both conditioned air emergency shutoff valves. At the same time, 115-volt ac power is applied to the "close" side of the crossover shutoff valve. When the switch is placed in either of the OFF positions (cabin or flight deck) it performs the following:

a. Applies 115-volt ac power through the control switch "off" contacts (cabin or flight deck, whichever is selected) to the "close" side of the respective system's emergency air shutoff valve; at the same time, 115-volt ac power is applied to the "open" side of the crossover shutoff valve.

C. Provides for both cabin and flight compartment Freon system operation in conjunction with the Freon compressor ON-OFF switch.

D. Supplies power to the cabin and flight compartment electric heater relays when the airplane is on the ground and the electronic temperature control calls for heater operation. This function is performed by applying 28-volt dc power to the sequencing device through the ground safety relays in the "ground" position. The 28-volt dc power is then available for heater relay operation when scheduled.

16. <u>Temperature Control AUTO-OFF-MAN Switches</u>

The temperature control AUTO-OFF-MAN switches are three-pole, double-throw switches. In the MAN position they allow manual temperature control through the manual temperature control MAN HOT-MAN COLD toggle switches. In the AUTO position, control of air temperature is automatically maintained by the electronic temperature control. When placed in the OFF position, control voltage to the sequencing device motor is interrupted and the sequencing device remains stationary. It interrupts control voltage to the heat exchanger cool air modulating valve so that valve position is maintained. Electrical power to the temperature control is also interrupted.

In the MAN position, the sequencing device actuator control winding and the heat exchanger cool air modulating valve are connected to the temperature control MAN HOT-MAN COLD switch. This allows use of the temperature control MAN HOT-MAN COLD switch to manually regulate temperature.

17. <u>Temperature Control MAN HOT-MAN COLD Switches</u>

The temperature control MAN HOT-MAN COLD switches are single-pole double-throw momentary switches which can only function when their respective temperature control AUTO-OFF-MAN switch is in the MAN position. The MAN HOT position increases the heating level of the system. The MAN COLD position increased the cooling level. The amount of heating or cooling is dependent on how long the switch is held in either position.

When held in the MAN HOT position, a connection is made to the proper control voltage at the electronic temperature control. The voltage rotates the sequencing device actuator toward the full hot schedule position;

voltage is also applied to the "close" side of the heat exchanger cooling air modulating valve. When held in the MAN COLD position, a connection is made to the proper control voltage from the electronic temperature control to rotate the sequencing device actuator toward the full cold schedule position. Voltage is also applied to the "open" side of the heat exchanger cooling air modulating valve.

18. 160 Degrees F Thermal Switch

The 160 degree F thermal switches are two-position switches which sense duct air temperature as it flows through the ducts to the cabin and flight compartments. Each switch is wired in parallel with the MAN COLD position of the manual temperature control MAN HOT-MAN COLD switch. In the event that maximum heat from the system is scheduled by manual control, this switch will actuate if the duct temperatures exceed 160 degrees Fahrenheit. When actuated, the results are the same as when the manual temperature control switch is held in the MAN COLD position.

19. Recirculating Blower ON-OFF Switch

The recirculating blower ON-OFF switch is utilized in recirculating the cabin air. Cabin air recirculation is accomplished by operating the recirculation fan and opening the recirculation control valve. Generally cabin air recirculation is utilized when the airplane is on the ground; however, it may also be used during flight if desired. When the switch is actuated to the ON position, the following functions occur.

A. Applicable to airplanes N802TW through N811TW, when the airplane is on the ground, 28-volt dc power is applied to the recirculation fan relay, energizing it and starting the fan. 28-volt dc power is also applied to energize relay K1. The K1 relay disconnects the "close" winding of the fresh air control valve from 115-volt ac power and connects the "close" winding of the recirculation control valve from 115-volt ac power and connects the "close" winding to the amplifier for modulation control power.

B. Applicable to airplanes N802TW through N811TW when in flight, and airplanes N801TW and N812TW through N830TW when either on the ground or airborne, 115-volt ac control voltage is transferred from one motor winding of the recirculation control valve to the other winding and the reference or capacitance coupled 115-volt ac voltage is transferred to the opposite winding. This transfer of control and reference voltage opens the recirculation control valve, applies 28-volt dc power to the recirculation fan relay, energizing it and starting the fan.

20. Reset Switches

The reset switches are utilized for manual recycling of lockout relays which have opened a power circuit due to an overheat, overspeed, or overpressure condition. A reset switch is incorporated in the lockout relay box on the Freon package. A similar switch is built into the recirculation fan lockout relay. The recirculation fan motor contains a normally-open thermal

switch. Should the motor become excessively hot, the thermal switch closes. Upon closing, 28-volt dc power is applied through a coil of the lockout relay which then cycles. Upon cycling, the relay interrupts the control circuit of the motor relay which then shuts off the motor. When the motor cools sufficiently, its self-operating thermal switch opens. The fan remains inoperative due to the lockout characteristics of the lockout relay. The reset switch in the lockout relay must be manually operated to recycle the lockout relay and complete the motor relay circuit for operation of the fan motor.

A Freon overpressure switch will cycle the lockout relay if pressure becomes excessive. Operation of the Freon compressor overspeed cutout device will also cycle the lockout relay. Operation of the lockout relays is the same as with the recirculation fan relay. The reset switch must be momentarily closed to energize the reset coil of the lockout relay. The overspeed protective device on the turbocompressor also incorporates a lockout mechanism and as in the case of the Freon package and recirculation fan, a manual reset is necessary. The condenser fan also utilizes the lockout and manual reset concept on its overspeed cutout device.

21. Electric Heater Thermal Switch

The electric heater thermal switch is self-operating and is located in the forward end of the heater. The switch contains three normally closed thermal limiters. Each limiter senses the temperature of one of the three "Y" connected coils of the first heating element. Should the temperature of one of the three coils of this element exceed 300 degrees, its corresponding thermal limiter opens. The open switch interrupts 28-volts dc power to the heater element relays. After the element has cooled below 300 degrees F, the switch again closes and 28-volt dc power is available for heater element relay operation.

22. Reverse Thrust Switch

The reverse thrust switch provides for operation of the thrust reverse relay. The switch is connected in series to complete the relay circuit whenever it is closed, provided the airplane is on the ground. When the thrust reverse relay is energized, it shuts off the turbocompressor by interrupting 28-volt dc power to the "on" windings and applies 28-volt dc power to the "off" windings of the turbocompressor on-off solenoid.

23. Turbocompressor Overspeed Switch

The turbocompressor overspeed switch is actuated by a flyweight assembly in the turbocompressor when a compressor overspeed condition occurs. The switch when actuated, shuts off the turbocompressor by: 1) interrupting the 28-volt dc power to the "on" winding of the turbocompressor on-off solenoid, 2) applying 28-volt dc power to the "off" winding of the turbocompressor on-off solenoid and 3) completing a circuit to energize the OVERSPEED TRIP indicator light on the flight engineer's control panel.

24. Ram Air Source Switch

The ram air source OPEN-CLOSE switch is a single-pole, double throw switch. Placing the switch in either the OPEN or CLOSE position will actuate the ram air shutoff valves toward the "open" or "closed" positions respectively. The valves will remain in a fixed position as set until the switch is again used.

25. Turbocompressor ON-OFF Switch

The turbocompressor ON-OFF switch is a double-pole double-throw switch. Normally the turbocompressors are operated during flight and shut down when the airplane is on the ground. In the OFF position, 28-volt dc power is applied to the "off" side of the turbocompressor on-off solenoid to close the turbocompressor shutoff valve. In the ON position, 28-volt dc power is applied to the "on" side of the turbocompressor on-off solenoid to open the turbocompressor shutoff valve.

26. Ground Safety Relays (Landing Gear Ground Safety Switch)

Although the landing gear ground safety switch is not a part of this system it controls a considerable portion of what happens in the air conditioning and pressurization subsystems. The safety switch is actuated when the airplane lands or becomes airborne. The switch controls the ground safety relays. They in turn are actuated to the "air" position or "ground" position corresponding to the landing gear ground safety switch. The ground safety relay contacts control the operation of components in the air conditioning subsystem.

27. Landing Gear Down and Locked Relay

The landing gear down and locked relay is energized by 28-volt dc power through a condenser cool air cutoff pressure switch and the landing gear down-and-lock switch. The relay performs three switch functions as follows:

A. The first function provides inflight or ground operation of the condenser cooling air modulating valve in the air conditioning subsystem. With the landing gear down and locked, and with low differential pressure between plenum chamber and ambient, the contact applies 115-volt ac power to close the valve.

With the landing gear up, or with a differential pressure of 0.5 psi or more between plenum chamber and ambient, the contact applies control voltage (through closed contacts of the Freon compressor motor relay) from the condenser minimum temperature control amplifier to provide amplifier control of the valve. The valve closes if the Freon compressor motor relay contacts are opened.

B. The second function provides inflight or ground operation of the condenser ground cooling air shutoff valve. When the relay is energized, the contact closes the valve by applying 115-volt ac power to the "close" side of the valve. When energized, the contact opens the valve by applying 115-volt ac power to the "open" side of the valve.

C. The third function provides control of the condenser fan in the Freon subsystem. When the relay is deenergized, the contact terminates power to the condenser fan motor relay. With the relay energized, the contact applies 28-volt dc power to the condenser fan motor relay. The 28-volt dc power comes through the closed position limit switch in the condenser ground cooling air shutoff valve, the sequencing device Freon on-off program cam swtich, the Freon compressor FLT DECK OFF - BOTH ON - CABIN OFF control switch and the closed Freon compressor ON-OFF switch.

SEQUENCING DEVICE - DESCRIPTION AND OPERATION

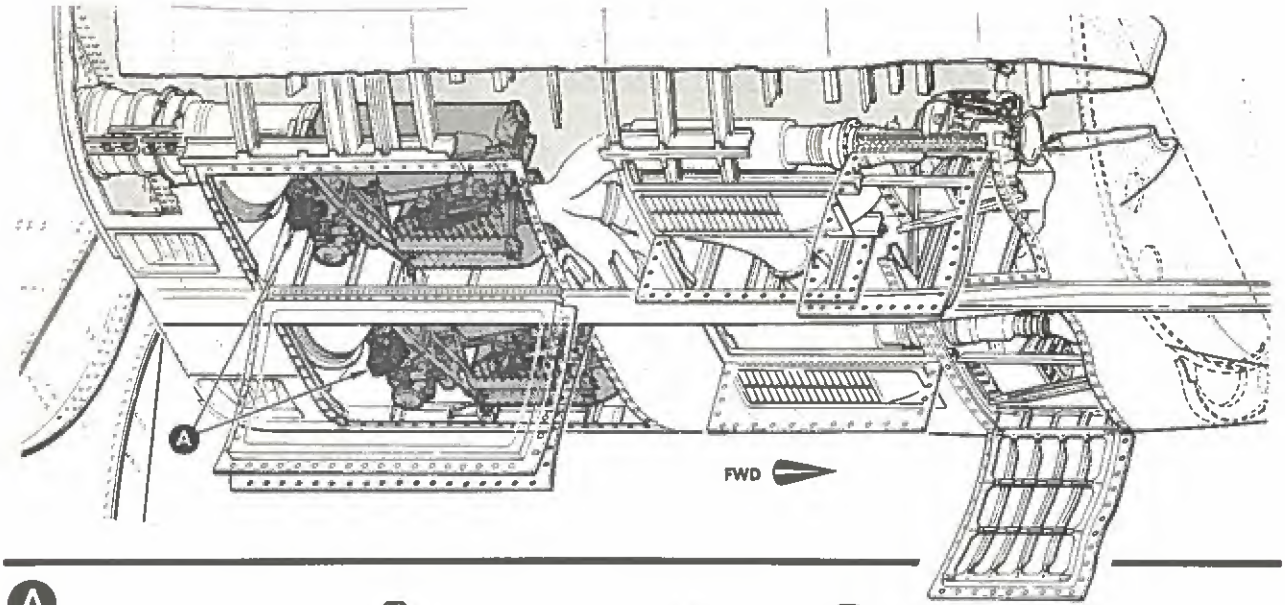
1. Description

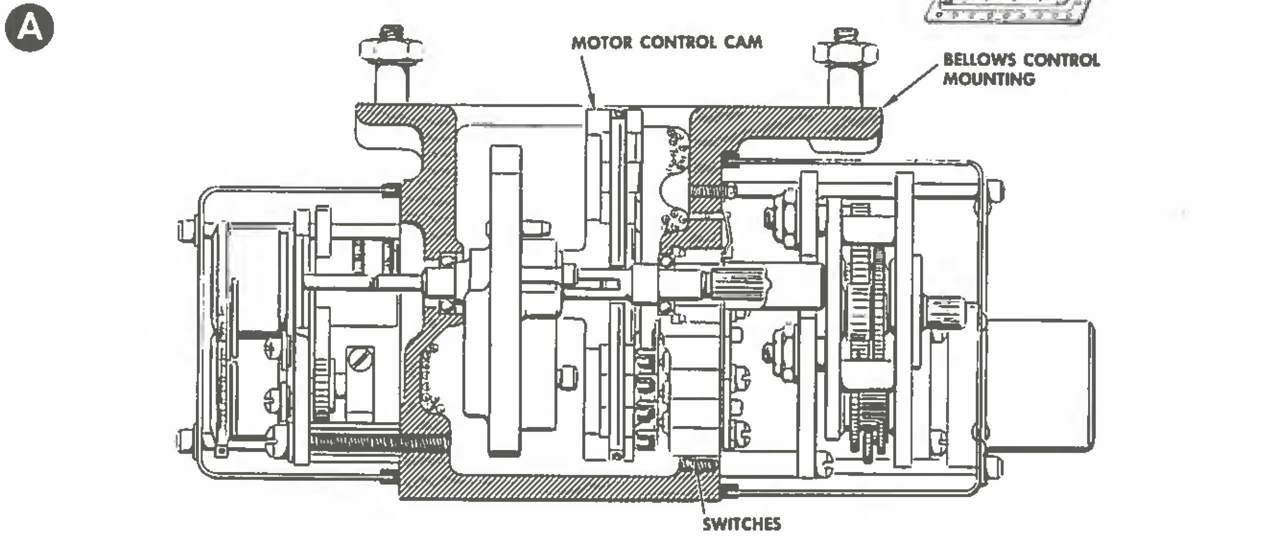
The sequencing device, illustrated on Figure 1, regulates the components of the air conditioning and turbocompressor subsystems to provide either heating or cooling. The sequencing device consists of an electric motor, gear train, cam shaft, cams, switches and potentiometers. The sequencing device motor operates in response to a control signal supplied by the electronic temperature control. The motor drives the cam shaft through a travel range of approximately 290 degrees. The cams on the shaft actuate the switches and potentiometers in a prescribed order to provide maximum cooling at the clockwise (0 degree) position and maximum heating at the counterclockwise (290 degree) position as viewed from the motor end of the device.

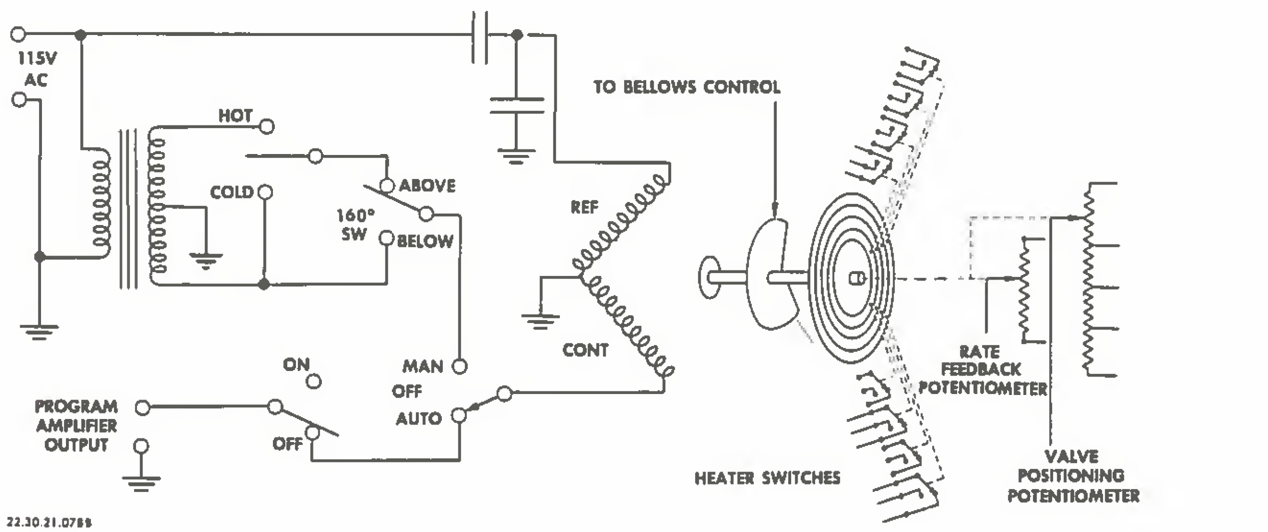
2. Operation

The sequencing device electric motor is a servo motor which has two phase windings. Rotor rotation is accomplished by applying ac voltage to the motor windings which have a phase differential of approximately 90 degrees. In this application, 57.5-volts ac is capacitance coupled to one winding of the motor as reference voltage. This reference voltage leads or lags the control voltage by 90 degrees as necessary to correct the temperature error. For manual operation, a center tapped transformer is used to rotate the sequencing device in either direction. When the temperature control MAN HOT-MAN COLD switch is placed in the MAN COLD position, the transformer supplies ac voltage which is in phase with the 115-volt ac source voltage. This provides a control voltage which lags the reference voltage by 90 degrees and the motor rotates in a clockwise direction to increase cooling. When the switch is placed in the MAN HOT position, the ac voltage from the transformer is 180 degrees out of phase with the 115-volt ac source voltage. This provides a control voltage which leads the reference voltage 90 degrees and the motor rotates counterclockwise to increase heating.

During automatic control, compartment temperatures are translated into leading or lagging phase voltage. These are amplified by the sequencing device amplifier and supplied to the sequencing device as control voltage. The phase of the voltage causes the motor to rotate and scheduling takes place.





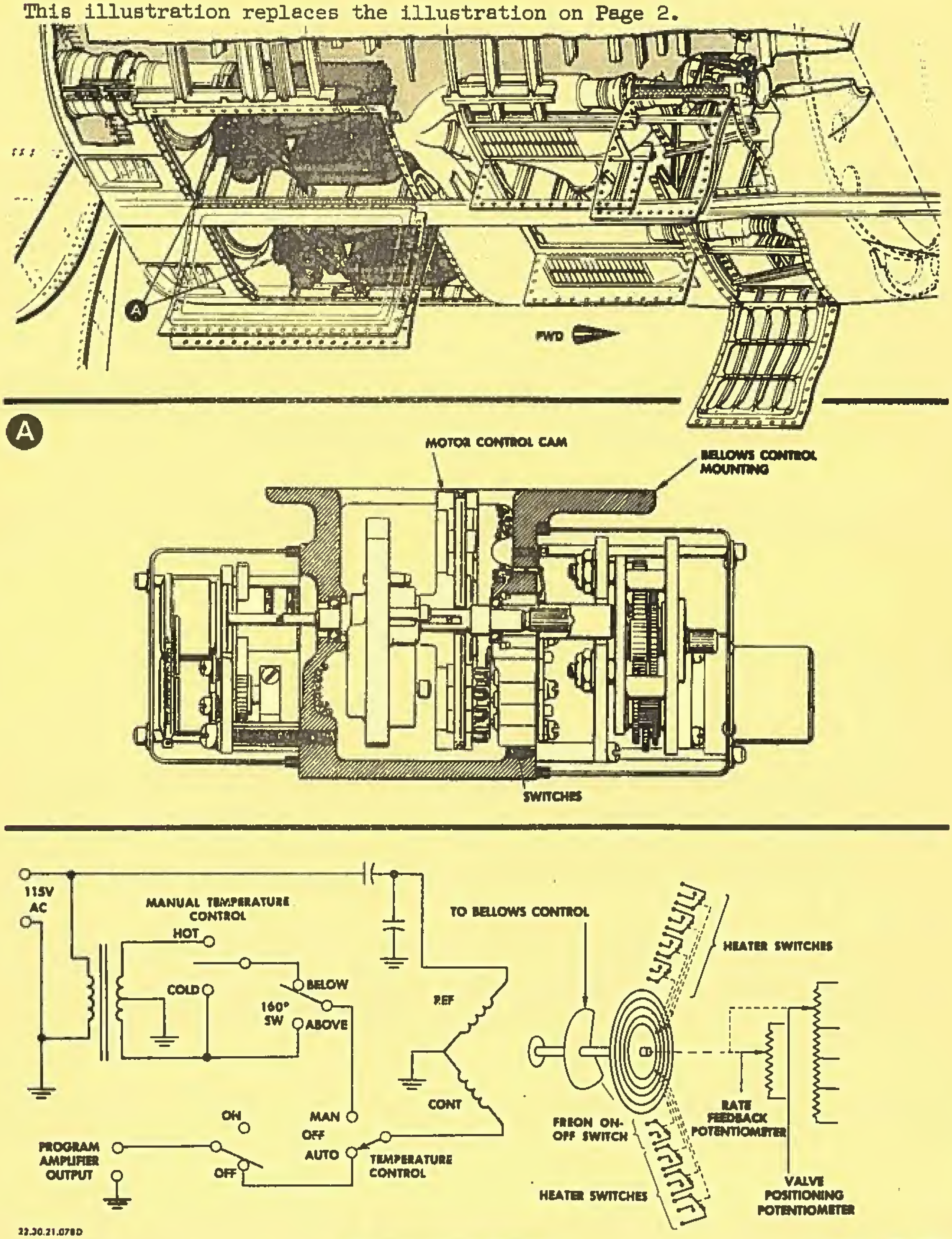


Sequencing Device
Figure 1

TEMPORARY REVISION NO. 21-38.

Insert facing 21-4-1, Page 2, dated May 25/61. This temporary revision supersedes Temporary Revision No. 21-37, dated Mar. 26/62.

This illustration replaces the illustration on Page 2.



Sequencing Device
Figure 1

SEQUENCING DEVICE - MAINTENANCE PRACTICES

1. Removal/Installation Sequencing Device (see Figure 201)

A. Equipment Required - None.

B. Preparation.

(1) Open ELEC TEMP CONTROL circuit breaker (cabin or flight compartment as required). Place warning tag on open circuit breaker.

(2) Open Freon package access door (cabin or flight compartment as required).

C. Remove Sequencing Device.

(1) If Freon package is mounted in airplane, disconnect electrical connector from sequencing device. (Cap connector and receptacle. Tag harness for installation.)

(2) While supporting sequencing device, cut lock wire and remove bolts securing sequencing device to bellows control on Freon package. (Bag and tag bolts and washers for installation.)

(3) Remove sequencing device.

D. Install Sequencing Device.

(1) Place open side of sequencing device against mounting flange on bellows control.

(a) The electric motor shall be toward the Freon package condenser.

(b) The back pressure cam in the sequencing device shall contact the bellows control cam follower.

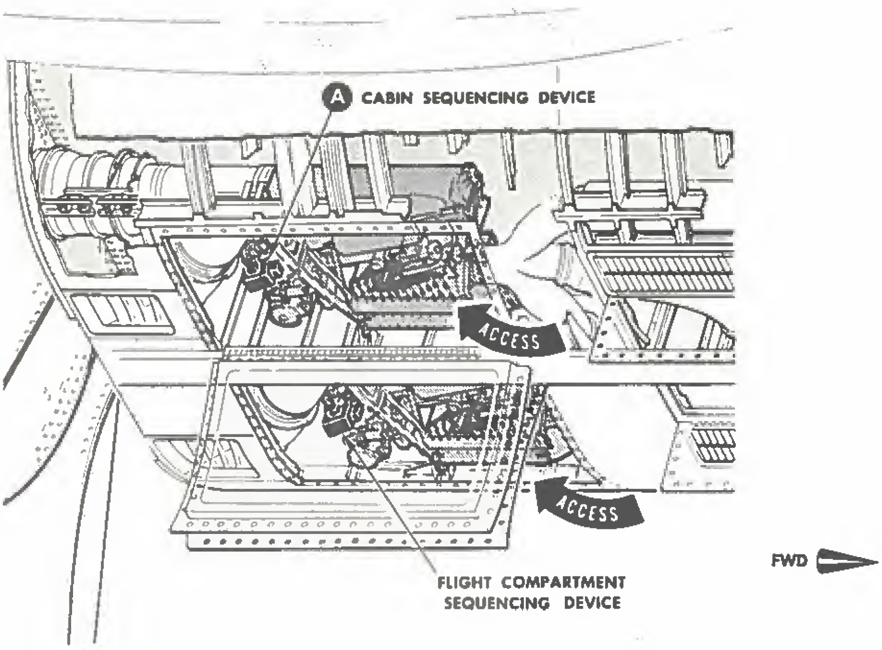
(2) Secure sequencing device to bottom of bellows control with bolts. Install bolts (with washers under bolt heads) through bellows control mounting flanges and screw bolts into threaded holes on sequencing device. Safety bolts with lockwire.

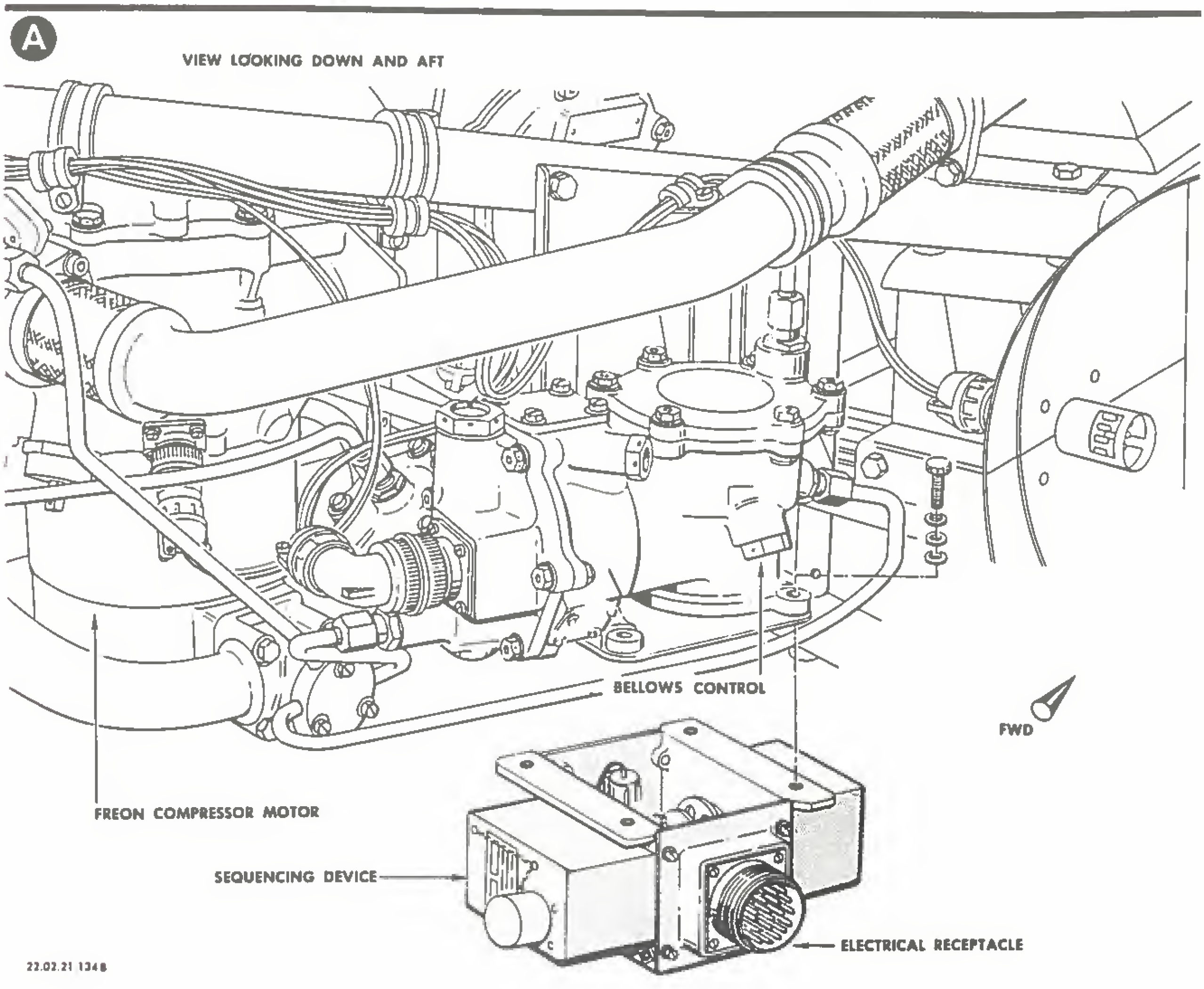
(3) If Freon package is installed in airplane, connect electrical harness from airplane to sequencing device.

(4) Remove warning tag and close ELEC TEMP CONTROL circuit breaker.

(5) Perform operational check of air conditioning system (refer to 21-0, Maintenance Practices).

(6) Close Freon package access door.





Sequencing Device Installation
Figure 201

2. Inspection/Check

A. Examine Sequencing Device Exterior.

(1) Check mounting flange for bends or distortion.

(2) Check the condition of external wiring.

(3) Examine receptacle terminals for damage.

(4) Check each cap or cover for dents, cracks or scratches.

(5) Examine all external surfaces for damage or worn paint.

3. Cleaning/Painting

A. Clean the Sequencing Device.

(1) Clean exterior surfaces with solvent, Specification AMS 3160A, to remove any dirt, grease or oil deposits.

CAUTION: DO NOT IMMERSE SEQUENCING DEVICE IN CLEANER. CLEAN EXTERIOR WITH LINTLESS CLOTH OR SOFT BRUSH MOISTENED WITH CLEANER.

(2) Remove deposits from the cams using a soft cloth moistened with cleaner.

B. Paint the Sequencing Device Housing.

(1) Touch up worn or damaged painted surfaces when the extent of damage does not exceed one square inch or five percent of the total painted area. When damage exceeds these limits send the sequencing device to overhaul.

(a) Remove corrosion with steel wool or crocus cloth prior to application of paint.

(b) Apply a priming coat of zinc chromate, Specification AMS 3110C, to obtain a semi-transparent greenish yellow surface.

(c) Allow primer to air dry 30 minutes at room temperature.

(d) Apply one coat of glyceryl phthalate black enamel, Specification AMS 3120B, with brush or spray.

CAUTION: MASK ALL PORTS AND UNPAINTABLE AREAS PRIOR TO PAINTING.

(e) Allow paint to air dry 4 hours at room temperature.

ELECTRONIC TEMPERATURE CONTROL - DESCRIPTION AND OPERATION

1. Description

The electronic temperature control consists of a power supply, comparison networks, magnetic modulator, and three amplifiers. Figure 1 illustrates the temperature control both pictorially and schematically.

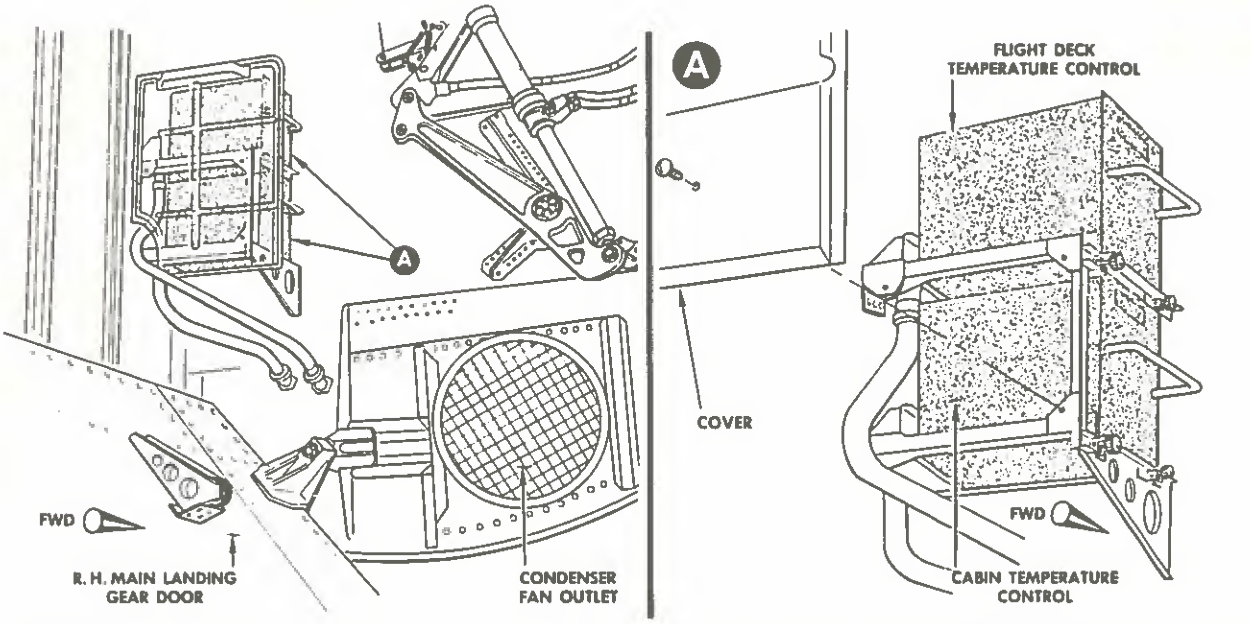
2. Operation

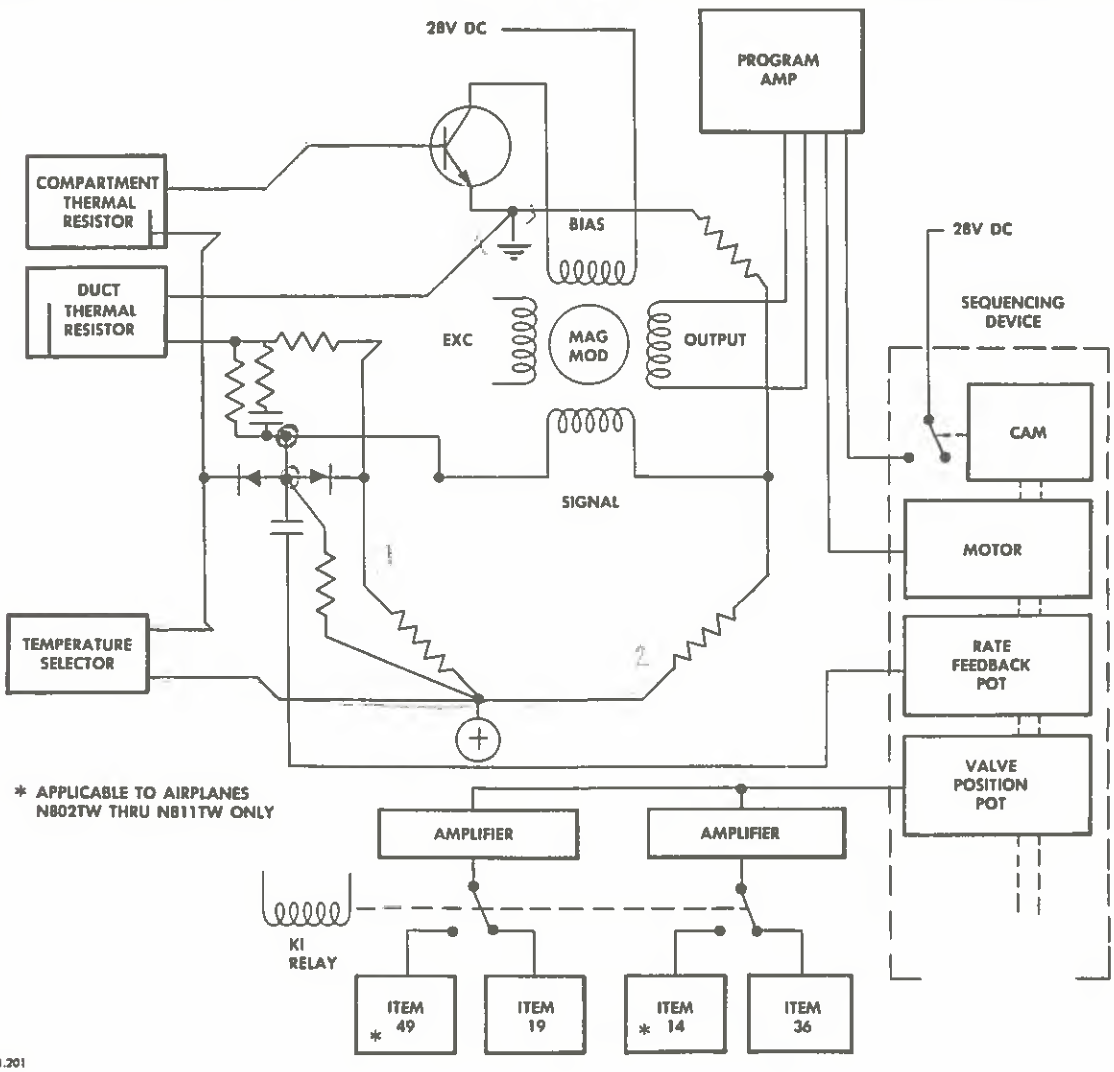
The power supply provides both ac and dc voltages for operation of the temperature control subsystem. The magnetic modulator utilizes ac voltage to convert a dc temperature error signal (plus the effect of sequencing device rate feedback and duct temperature rate of change) into an ac voltage, which is then amplified to drive the sequencing device motor. On airplanes N802TW through N811 TW the sequencing device and the valve amplifiers are actuated with a dc voltage to amplify an an error voltage between the sequencing device positioning potentiometer and the recirculation control valve, heat exchanger cooling air modulating valve, fresh air control valve and heat control modulating valve position feedback potentiometers. On airplanes N801TW and N812TW through N830TW, only the cooling air modulating valve and heat control modulating valve position feedback potentiometers are connected to the electronic temperature control. The amplified ac voltage drives these same valve to reduce the error voltage.

The comparison network incorporates two bridge circuits, one for compartment temperature error and the other for duct temperature limit. A diode switching circuit permits the duct limit bridge to override the cabin bridge when the duct temperature limit is attained (approximately 130 degrees F). The signal from the bridge summing point is then fed to the signal winding of the magnetic modulator. The cabin bridge consists of a thermal resistor and the temperature selector plus suitable balancing fixed resistors. The duct limit bridge consists of a thermal resistor plus a preset voltage divider network.

The magnetic modulator receives dc current flow in either direction from the bridge unbalance. Output of the magnetic modulator is an ac signal voltage which has either a leading or lagging phase depending on direction of dc current flow caused by the bridge unbalance.

There are three transistor type amplifiers within the temperature control. These are the amplifiers for (1) the heat exchanger cooling air modulating valve and fresh air control valve, the amplifier for (2) the heat control modulating valve and the recirculation control valve; and (3) the sequencing device amplifiers. All are similar, consisting of a two stage push-pull transistor amplifier. The transistors are NPN type for the first stage and PNP type for the second stage. Circuit application is "common emitter." The input signal is applied between base and emitter and the output signal is generated between collector and emitter.





Temperature Control
Figure 1

ELECTRONIC TEMPERATURE CONTROL - MAINTENANCE PRACTICES

1. Removal/Installation Electronic Temperature Control

A. Equipment Required - None.

B. Preparation.

(1) Open cabin or flight compartment ELEC TEMP CONTROL circuit breaker as required. (Place warning tag on open circuit breaker.)

(2) Open the right main landing gear door (refer to Chapter 32, LANDING GEAR).

C. Remove Electronic Temperature Control.

(1) Unlock three quick-type fasteners securing protective cover to temperature control mounting bracket; remove cover.

(2) Remove safety wire and loosen two knurled nuts which lock temperature control in mounting rack. (Knurled nuts will swing free of control when loosened.)

(3) Grasp handle on temperature control and pull control outboard to remove mounting rack.

CAUTION: PULL TEMPERATURE CONTROL OUTBOARD HORIZONTALLY TO PREVENT DAMAGE TO ELECTRICAL CONNECTOR IN BACK OF CONTROL.

D. Install Electronic Temperature Control.

(1) Slide temperature control inboard on mounting rack located in right hand main landing gear wheel well.

CAUTION: BE SURE THAT TEMPERATURE CONTROL IS PROPERLY CENTERED IN RACK BEFORE SLIDING ALL THE WAY INBOARD. IMPROPER ALIGNMENT MAY DAMAGE THE CONNECTOR IN BACK OF THE CONTROL.

(2) Raise knurled nuts into position over locking pins on face of control. Tighten nuts by hand only and install safety wire.

(3) Place protective cover over temperature control and mounting bracket; lock three quick-type fasteners to secure cover to mounting bracket.

(4) Remove warning tag and close ELEC TEMP CONTROL circuit breaker.

(5) Perform operational check of air conditioning system (refer to 21-0, Maintenance Practices).

2. Inspection/Check

A. Visual Check.

(1) Examine control exterior for the following:

(a) Paint shall not be damaged.

(b) Surfaces shall not be bent or dented enough to cause malfunction due to distortion or grounding of internal components.

(2) Examine electrical receptacle; it shall not show damage or distortion.

(3) Examine interior components of control.

(a) Electrical connections shall be mechanically and electrically secure.

(b) Fuses shall be secure in their mounting clips.

(c) Screws and nuts shall be tight.

(d) Resistors and capacitors supported and fastened by their electrical leads shall be positioned to prevent shorts.

(4) Examine protective cover, it shall be fully seated against the face of the control and the screws that fasten it to the control shall be tight.

3. Cleaning/Painting

A. Clean temperature control.

(1) Wipe control with a lint free cloth dampened, not saturated, with AMS 3160A solvent to remove grease or oil deposits.

NOTE: Do not immerse control in solvent or allow solvent to enter the control or electrical receptacle.

(2) Clean interior of control and electrical receptacle with soft clean brush and with oil and moisture free low pressure compressed air.

NOTE: Inhibisol, manufactured by the Pentone Company, 75 Hudson Ave., Tenafly, New Jersey may be used to clean the interior of the temperature control.

B. Paint temperature control.

(1) Touch up worn or damaged painted surfaces as follows:

(a) Apply a primer coat of zinc chromate AMS 3110C to obtain a semi-transparent greenish-yellow surface.

(b) Allow primer to air dry 30 minutes at room temperature.

(c) Apply two topcoats of glyceryl phthalate black enamel, AMS 3120.

(d) Allow each coat of enamel to air dry 4 hours at room temperature before applying the second coat or before handling.

4. Approved Repairs

A. Remove corrosion on exposed metal surfaces.

(1) Polish out with fine crocus cloth and repaint.

B. Replace power input and manual control power fuses.

(1) Remove protective cover from control.

(a) Remove cover fastening screws.

(b) Slide cover off receptacle end of control.

(2) Locate two fuses mounted above the manual transformer at the electrical receptacle end of the control.

(a) The outboard fuse is the manual fuse.

(b) The inboard fuse is the power input fuse.

(c) Replace the blown fuse.

CAUTION: SIX AMPLIFIER FUSES ARE LOCATED ON THE OPPOSITE SIDE OF THE POWER INPUT AND MANUAL FUSE MOUNTING CLIPS. SHOULD A BLOWN AMPLIFIER FUSE BE ENCOUNTERED, DO NOT REPLACE FUSE. SEND MALFUNCTIONING CONTROL TO OVERHAUL.

(3) Replace protective cover on control.

(a) Slide cover over receptacle end of control.

(b) Seat cover fully and secure with cover fastening screws.

C. Replace protective cover and screws as required.

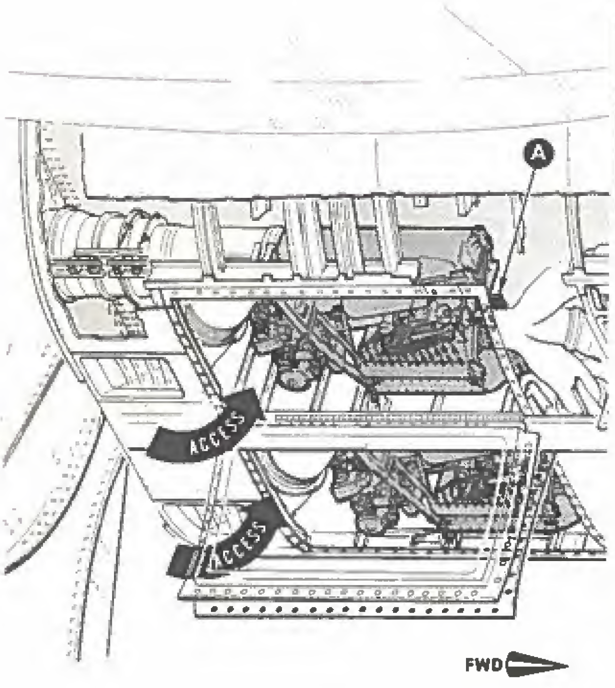
FREON LOCKOUT RELAY - DESCRIPTION AND OPERATION

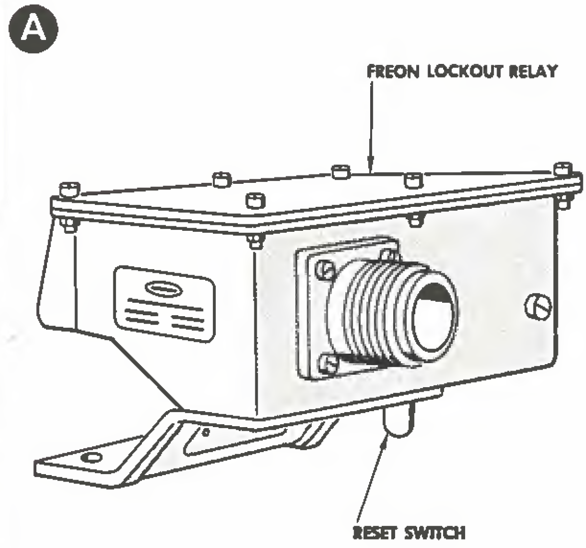
1. Description

The lockout relay, shown on Figure 1, is bracket mounted on the forward end of the evaporator. The lockout relay is a junction box which connects the control power receptacles to the package electrical harness. The box contains a magnetic relay and a reset switch. The junction box provides a central connecting point for interharness connections as well as connections to the power receptacle, switch, and relay. The relay is a magnetic latching relay containing two permanent magnets.

2. Operation

The lockout relay normally provides a ground connection to complete the Freon compressor motor relay coil circuit. This permits the motor relay to be energized and route ac power to the compressor motor. If one leg of the three-phase power to the compressor motor is lost, or if the compressor discharge pressure, the compressor discharge temperature, or the compressor motor temperature exceeds permissible limits, the lockout relay will deenergize the motor relay to shut down the Freon compressor. The lockout relay can be reset for normal operation by pushing the button on the bottom of the lockout relay box. (Electrical power is required to energize the reset winding of the relay.)





Freon Lockout Relay
Figure 1

FREON LOCKOUT RELAY - MAINTENANCE PRACTICES

1. Removal/Installation Freon Lockout Relay (see Figure 201)

   A. Equipment Required - None.

   B. Preparation.

      (1) Open FREON SYS CONT circuit breaker (cabin or flight compartment as required). Place warning tag on open circuit breaker.

      (2) Open Freon package access door (cabin or flight compartment as required).

   C. Remove Freon Lockout Relay.

      (1) Disconnect electrical connectors on forward and aft ends of the Freon lockout relay. Lockout relay is mounted on upper forward end of Freon evaporator. (Cap connectors and receptacles. Tag harnesses for installation.)

      (2) Remove two nuts and washers from upper end of evaporator mounting bolts.

      (3) Remove evaporator mounting bolts and spacers to release lockout relay from Freon package. (Bag and tag hardware for installation.)

   D. Install Freon Lockout Relay.

      (1) Position lockout relay so that relay mounting brackets extend above and below the upper mounting bracket on forward end of Freon evaporator.

      (2) Position larger spacer and two washers as illustrated, and insert evaporator mounting bolts from the bottom.

      (3) Secure bolts in position with washer and nut on top.

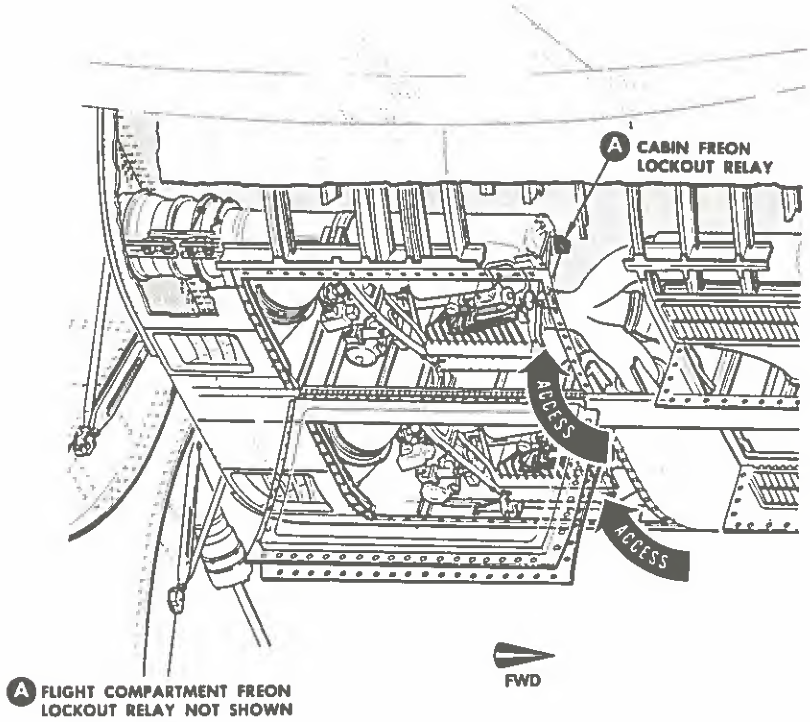
      (4) Connect electrical connector to forward and aft receptacle on lockout relay.

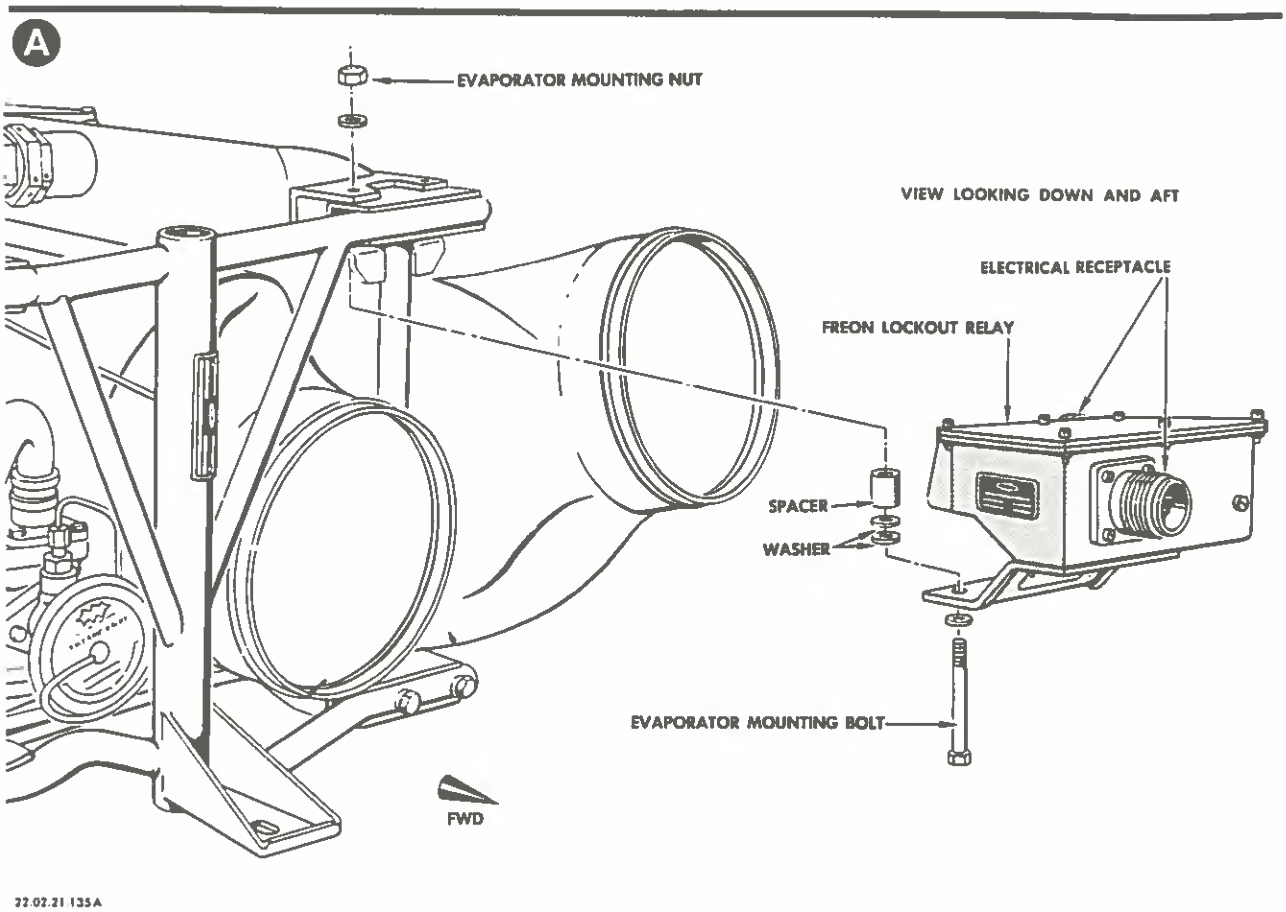
      (5) Perform operational test (refer to Adjustment/Test).

2. Adjustment/Test

   A. Equipment Required.

      (1) A locally manufactured test harness consisting of a connector, two wires and a switch. The connector must fit the Freon compressor motor temperature protection switch, the compressor discharge





Freon Lockout Relay Installation
Figure 201

temperature protection switch, or the compressor discharge pressure protection switch. The switch, when closed, must connect the two terminals on the connector to simulate the closing of a protection switch on the Freon package.

(2) External source of 115/200 volt, 400 cycle, three phase electrical power.

B. Preparation.

(1) Open Freon package access door (cabin or flight compartment as required).

(2) Connect external source of electrical power to airplane (refer to Chapter 24, ELECTRICAL POWER).

(3) Start and operate Freon package which is to be tested (refer to 21-0, Maintenance Practices).

C. Test Freon Lockout Relay.

NOTE: If the lockout relay has been replaced, it may be in the lockout position. If the FREON FAIL warning light is illuminated, press the reset button on the bottom of the lockout relay to start the compressor motor and condenser fan. (Electric power is required to reset the lockout relays.)

(1) Remove connector from one of the protection switches and connect the test harness. (Be sure harness switch is in the open position.)

(2) With Freon compressor motor running, close switch on the test harness to simulate an overpressure or overtemperature condition. The Freon package shall shut down, and the FREON FAIL warning light shall illuminate.

(3) With the relay in the lockout position, press the reset button on bottom of the Freon lockout relay. The condenser fan shall start operating immediately and the FREON FAIL warning light shall extinguish. After a delay of approximately 20 seconds, the Freon compressor shall start.

(4) When tests are completed, shut down system and remove the test harness. Connect package harness connector back to the switch from which it was removed.

(5) Close the Freon package access door.

(6) Disconnect external electrical power from airplane (refer to Chapter 24, ELECTRICAL POWER).

CONDENSER TEMPERATURE CONTROL - DESCRIPTION AND OPERATION

1. Description

The condenser temperature control is mounted on top on the evaporator Freon outlet header near the aft frame. It contains a receptacle for connection to an electrical harness and consists essentially of a power supply, transistor amplifier, magnetic modulator and a resistance bridge circuit.

The power supply provides ac and dc voltage for operation of the magnetic modulator, and dc voltage for operation of the amplifier and bridge circuit.

The magnetic modulator contains the signal, excitation, bias, and output windings. The signal winding is connected between the summing points of the bridge. The excitation winding is supplied with an ac voltage, and the bias winding with a dc voltage. The output from the magnetic modulator is generated in the output winding.

The excitation voltage is inductively induced into the output winding when the modulator is properly biased and supplied with a dc signal voltage. The dc current flow through the bias coil provides a null point above ground at which point the ac output from the modulator is zero. Varying the dc signal current either plus or minus from the bridge circuit will vary the ac output voltage so that it will be in phase or 180 degrees out of phase with the excitation voltage. Thus, the direction and amount of current flow through the signal winding will determine the phase and amplitude of the voltage from the output winding of the magnetic modulator.

The output from the magnetic modulator is amplified by means of the two stage push-pull transistor amplifier. The transistors used are NPN type for the first stage and PNP type for the second stage. Circuit application of the transistors in both stages is "common emitter". In this arrangement, the input signal is applied between base and emitter with the output generated between collector and emitter.

2. Operation

The condenser temperature control functions in conjunction with a thermal resistor and connector located in the condenser ram air outlet duct, and the condenser cooling air modulating valve. It uses the variable resistance of the thermal resistor and connector to provide a control voltage of the proper phase to position the cooling air modulating valve.

The thermal resistor and connector completes the bridge circuit of the temperature control. When ram air from the condenser core is at a predetermined temperature, the resistance of the thermal resistor is such that the bridge is in balance and no current flows through the signal winding of the magnetic modulator. When this condition exists, no signal is generated at the output of the modulator to provide control voltage to the condenser cooling air modulating valve, and the valve remains in a set position.

Should condenser ram air discharge temperatures increase, the resistance of the thermal resistor and connector decreases, causing bridge circuit unbalance and current flow through the signal winding of the magnetic modulator. The ac output from the output winding will have the proper phase to provide a control voltage to drive the condenser cooling air modulating valve toward the open position. Should condenser ram air discharge temperatures decrease, resistance of the thermal resistor and connector increases, causing bridge unbalance and subsequent current flow through the signal winding of the modulator in the opposite direction as with increasing ram air temperatures. The control voltage under these conditions has a 180 degree phase shift to drive the condenser cooling air modulating valve toward the closed position.

A second voltage signal, beside the error voltage from bridge unbalance, is applied to the signal winding of the magnetic modulator. This is a voltage proportional to the rate of change of the condenser cooling air modulating valve actuator rotation. This voltage is capacitance coupled to the signal winding from the rate feedback potentiometer wiper in the valve and is only applicable when the potentiometer wiper is moved (valve actuator rotation occurs). Thus, once valve actuator rotation has started, the rate of change voltage from the potentiometer wiper reduces the initial starting signal to the valve actuator to keep rotation at a slow rate.

CONDENSER TEMPERATURE CONTROL - MAINTENANCE PRACTICES

1. Removal/Installation Condenser Temperature Control (see Figure 201)

   A. Equipment Required - None.

   B. Preparation.

      (1) Open FREON SYS CONT, COND GND COOLING and ELEC TEMP CONTROL circuit breakers (cabin or flight compartment as required). Place warning tags on open circuit breakers.

      (2) Open the Freon package access door (cabin or flight compartment as required).

   C. Remove Condenser Temperature Control.

      (1) Disconnect electrical connector on top of condenser temperature control. (Cap connector and receptacle. Tag harness for installation.)

      (2) Remove four mounting bolts which secure control to Freon package frame. (Bag and tag hardware for installation.)

      (3) Remove condenser temperature control.

   D. Install Condenser Temperature Control.

      (1) Position condenser temperature control against package frame with the electrical receptacle on top and the fuse box aft.

      (2) Insert four mounting bolts through the control and into the package frame; secure in position with washers and nuts.

      (3) Connect electrical connector to condenser temperature control.

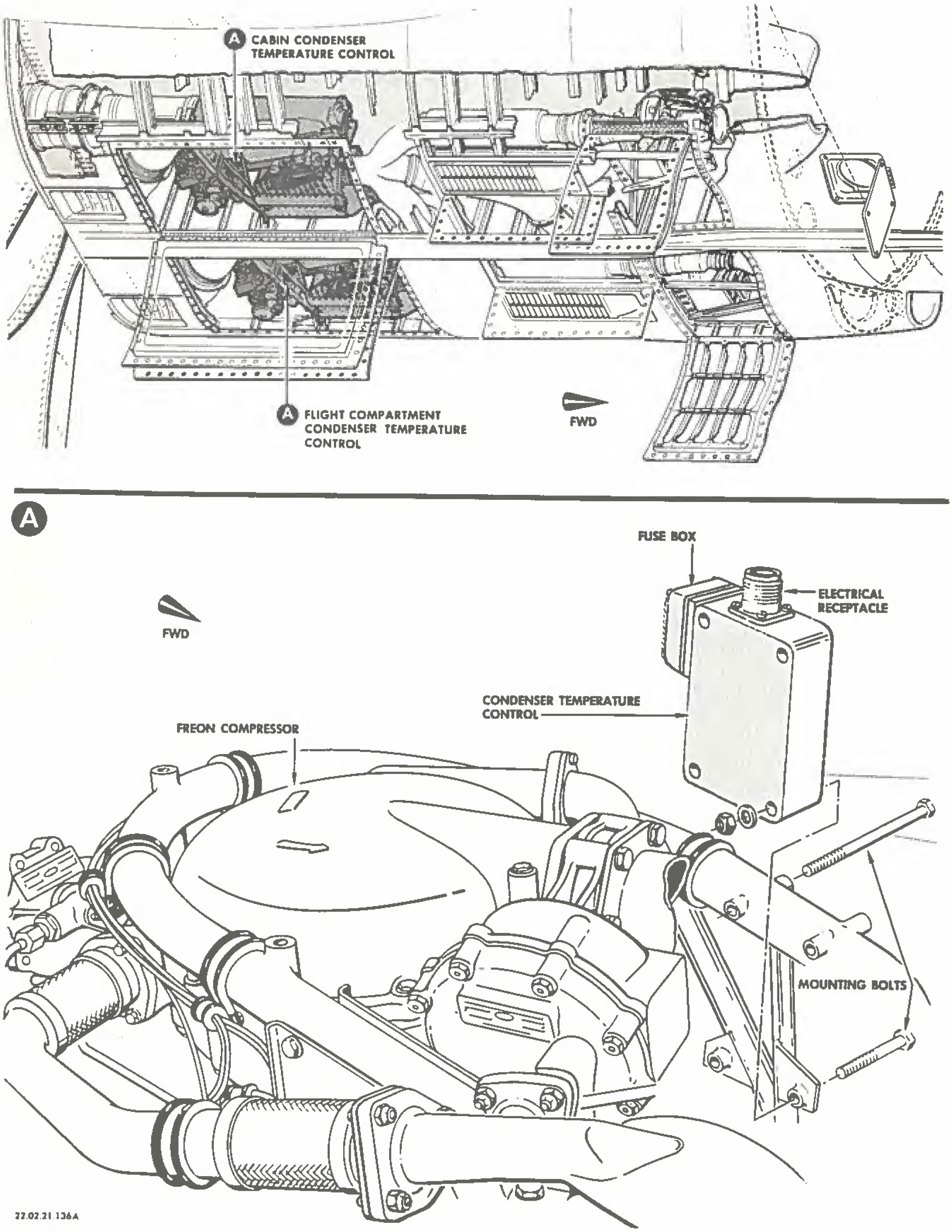
      (4) Close FREON SYS CONT, COND GND COOLING and ELEC TEMP CONTROL circuit breakers and remove warning tags.

      (5) Perform operational check of air conditioning system (refer to 21-0, Maintenance Practices).

2. Inspection/Check

   A. Examine the exterior of the control for visual damage to the paint or cracks in the potting material.

      (1) Determine if the crack has affected any electronic wiring, if so, replace the control.



Condenser Temperature Control Installation
Figure 201

B. Check the electrical receptacle for damage or distortion.

C. Check mounting bolts for security.

3. <u>Cleaning/Painting</u>

A. Clean the condenser temperature control.

(1) Wipe with a lint free cloth dampened with solvent, Specification AMS 3160A, to remove grease or oil deposits.

<u>NOTE:</u> Do not immerse the unit in solvent nor allow the solvent to enter the fuse box or electrical receptacle.

B. Paint the condenser temperature control case.

(1) Mask off electrical receptacle and identification plate.

(2) Prime with a thin coat of zinc chromate, Specification AMS 3110, to obtain a semitransparent greenish coating.

(3) Allow prime coat to dry 30 minutes at room temperature.

(4) Apply a coat of black lacquer, Specification MIL-L-6805.

(5) Allow to dry 45 minutes at room temperature.

4. <u>Approved Repair</u>

A. Remove corrosion on exposed metal surfaces.

(1) Polish out with fine crocus cloth.

B. Replace mounting bolts as needed.

TEMPERATURE SELECTOR - DESCRIPTION AND OPERATION

1. Description

The temperature selector is located on the flight engineer's control panel. It is a potentiometer-type adjustable resistor which can be varied manually by turning a knob. A high resistance setting provides low cabin temperature; low resistance setting provides high cabin temperatures. Variation of its resistance from a previous setting causes an unbalance within the temperature control. The unbalance is created by a difference between selector resistance and thermal resistor resistance. The resistance of the thermal resistors is varied by compartment temperature. Consequently, compartment temperatures are altered to change thermal resistance to again maintain balance between the thermal resistor and the temperature selector.

TEMPERATURE SELECTOR - MAINTENANCE PRACTICES

1. Removal/Installation Temperature Selector

   A. Equipment Required - None.

   B. Preparation.

      (1) Open ELEC TEMP CONTROL circuit breaker (cabin or flight compartment as required). Place warning tag on open circuit breaker.

   C. Remove Temperature Selector. (Cabin or flight compartment.)

      (1) Remove selector knob from shaft on temperature selector (on front of flight engineer's control panel).

      (2) Remove plastic edge lighting panel from section containing temperature selector (refer to Chapter 33, LIGHTS).

      (3) Open flight engineer's control panel (refer to Chapter 31, INSTRUMENTS).

      (4) Disconnect electrical connector from rear of temperature selector. (Cap connector and receptacle. Tag connector for installation.)

      (5) Remove mounting nut from selector shaft which secures temperature selector to panel. (Support selector while removing nut.)

      (6) Remove temperature selector from back of panel.

   D. Install Temperature Selector. (Cabin or flight compartment.)

      (1) Insert temperature selector shaft through mounting hole from back side of panel.

      (2) Install mounting nut loosely on shaft on front side of panel.

      (3) Position selector so that key is at the 9 o'clock position when viewed from front of panel.

      (4) Tighten mounting nut while supporting selector from rear.

      (5) Connect electrical connector to rear of temperature selector.

      (6) Close flight engineer's control panel (refer to Chapter 31, INSTRUMENTS).

      (7) Install plastic edge lighting panel over flight engineer's control panel (refer to Chapter 33, LIGHTS).

      (8) Install selector knob on shaft.

(9) Remove warning tag and close ELEC TEMP CONTROL circuit breaker.

(10) Perform operational check of air conditioning system (refer to 21-0, Maintenance Practices).

2. Adjustment/Test

A. Equipment Required

(1) Resistance bridge (Leeds and Northrup type 4760 or equivalent.)

B. Test the Temperature Selector.

(1) Using resistance bridge, measure the resistance between pins A and B of the selector. With the shaft in the full counterclockwise position, as viewed from the shaft end, the resistance shall be 8122 to 8798 ohms. With the shaft in the full clockwise position, as viewed from the shaft end, the resistance shall be a maximum of 100 ohms.

(2) If resistance in either shaft position is outside the specified range, replace the temperature selector.

3. Inspection/Check

A. Examine the exterior of the temperature selector for visual damage to the paint or cracks in the potting material.

B. Check the selector mounting threads and the electrical receptacle threads for damage.

C. Check that the receptacle mounting screws and the nut which fastens the potentiometer to the selector frame are tight.

4. Cleaning/Painting

A. Clean the temperature selector.

(1) Wipe external surfaces with a clean dry cloth.

(2) Clean interior of electrical receptacle with a soft clean brush.

B. Paint the temperature selector.

(1) Mask off electrical receptacle, potentiometer shaft, and identification plate.

(2) Prime with a thin coat of zinc chromate, Specification AMS 3110, to obtain a semitransparent greenish coating.

(3) Allow prime coat to dry 30 minutes at room temperature.

(4) Apply a coat of black lacquer, Specification MIL-L-6805.

(5) Allow to dry 45 minutes at room temperature.

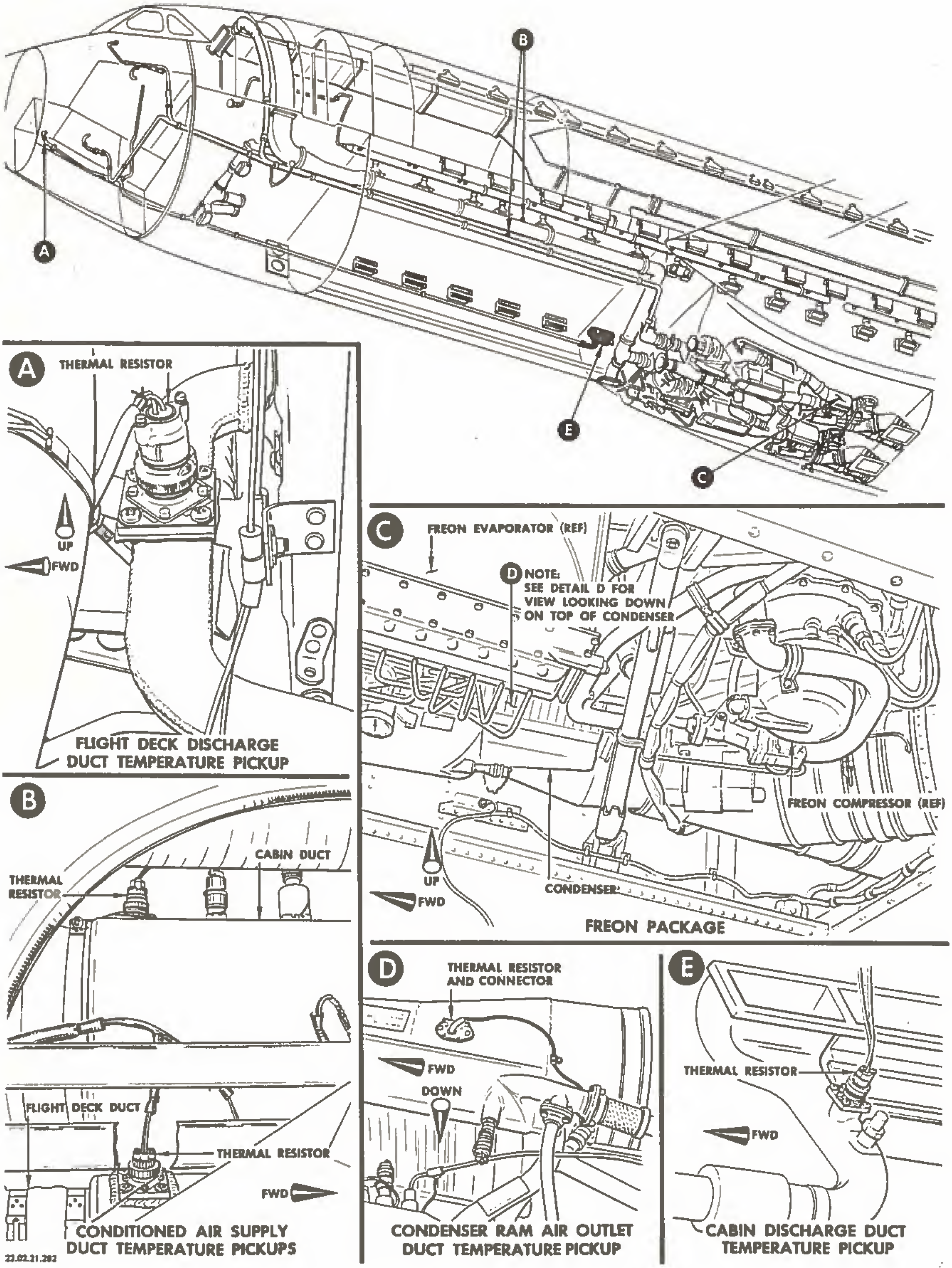
THERMAL RESISTORS - DESCRIPTION AND OPERATION

1. Description

The thermal resistor, shown on Figure 1, consists of ten thermistors of equal value, wired in parallel, and mounted in a disc which is supported in the sensing end of a ported housing. The bulb ends of the thermistors are exposed in order to sense the temperature of the air flowing past. As the temperature of the air changes, the resistance of the thermistors also changes. This variation in resistance is used to control various temperature regulating functions in the air conditioning system.

2. Operation

Four thermal resistors and two thermal resistors and connectors are used in the air conditioning system to serve as temperature pickups. They transmit temperature information to the control amplifiers which, in turn, regulate the operation of the system. Thermal resistors are located in the conditioned air ducts of both the cabin and flight deck systems and in the cabin and flight deck discharge ducts. A thermal resistor and connector is located in the condenser ram air outlet of each Freon package.



Thermal Resistors
Figure 1

THERMAL RESISTOR - MAINTENANCE PRACTICES

1. Removal/Installation Thermal Resistor

   A. Equipment Required - None.

   B. Preparation.

      (1) Open ELEC TEMP CONTROL circuit breaker (cabin or flight compartment as required). Place warning tags on open circuit breakers.

   C. Remove Conditioned Air Duct Pickup Thermal Resistor (cabin or flight compartment).

      (1) Release forward cargo compartment line fasteners (zippered panels) on left bulkhead between stations 500 and 525. (On side opposite the cargo compartment door and about one foot aft of the door.) Open liner for access to the thermal resistor.

      (2) Disconnect electrical connector from thermal resistor.

      NOTE: Thermal resistors are mounted on top of the conditioned air ducts. The large duct is the cabin supply and the small duct is the flight compartment supply.

      (3) Remove four screws holding the thermal resistor in position. (Bag and tag for installation.)

      (4) Lift thermal resistor from duct.

   D. Install Conditioned Air Duct Pickup Thermal Resistor (cabin or flight compartment).

      (1) Insert thermal resistor through gasket into mounting hole on top of conditioned air duct.

      (2) Align mounting holes and install four mounting screws loosely.

      (3) Tighten four mounting screws.

      (4) Connect electrical connector to thermal resistor.

      (5) Close and fasten cargo compartment liner (zippered panels).

      (6) Remove warning tag and close ELEC TEMP CONTROL circuit breaker.

      (7) Perform operational check of air conditioning system (refer to 21-0, Maintenance Practices).

E. Remove Cabin Discharge Duct Thermal Resistor.

(1) Release liner fasteners at aft bulkhead of forward cargo compartment.

(2) Locate cabin discharge duct in upper right hand corner of accessory compartment. The forward branch of the discharge duct contains the cabin discharge duct thermal resistor.

(3) Disconnect electrical connector from thermal resistor. (Cap connector and receptable. Tag harness for installation.)

(4) Remove four screws which hold thermal resistor in position. (Bag and tag for installation.)

(5) Remove thermal resistor.

F. Install Cabin Discharge Duct Thermal Resistor.

(1) Insert thermal resistor through gasket into mounting hole in cabin discharge duct.

(2) Align mounting holes and install four mounting screws loosely.

(3) Tighten four mounting screws.

(4) Connect electrical connector to thermal resistor.

(5) Close cargo compartment liner.

(6) Remove warning tag and close the ELEC TEMP CONTROL circuit breaker.

(7) Perform operational check of air conditioning system (refer to 21-0, Maintenance Practices).

G. Remove Flight Compartment Discharge Duct Thermal Resistor.

(1) Enter right hand tunnel access door.

(2) Locate the flight compartment discharge duct. The thermal resistor is located on the duct where it leaves the flight compartment forward of the co-pilot's rudder pedals.

(3) Disconnect electrical connector from the thermal resistor. (Cap connector and receptacle. Tag harness for installation.)

(4) Remove four screws which hold the thermal resistor in position.

(5) Remove thermal resistor.

H. Install Flight Compartment Discharge Duct Thermal Resistor.

(1) Insert thermal resistor through gasket and into mounting hole on the flight compartment discharge duct.

(2) Align mounting holes and install four mounting screws loosely.

(3) Tighten four mounting screws.

(4) Connect electrical connector to thermal resistor.

(5) Remove warning tag and close ELEC TEMP CONTROL circuit breaker.

(6) Perform operational check of air conditioning system (refer to 21-0, Maintenance Practices).

I. Remove Condenser Ram Air Outlet Duct Thermal Resistor and Connector.

(1) Open Freon package access door (cabin or flight compartment as required).

(2) Remove Freon package (refer to 21-3-1, Maintenance Practices).

(3) Remove nut, washer and screw securing cable clamp to lead between thermal resistor and connector.

(4) Remove nuts, washers and screws securing connector on thermal resistor and connector.

(5) Remove screws securing thermal resistor to top of condenser; remove thermal resistor and connector.

J. Install Condenser Ram Air Outlet Duct Thermal Resistor and Connector.

(1) Place thermal resistor in hole in condenser.

<u>NOTE:</u> Check for presence of gasket between condenser and thermal resistor.

(2) Position connector on mounting bracket on condenser; secure with screws, washers and nuts.

(3) Install cable clamp on lead between thermal resistor and connector.

(4) Connect electrical receptacles of Freon package harness and thermal resistor and connector.

(5) Install Freon package (refer to 21-3-1, Maintenance Practices).

(6) Close Freon package access door.

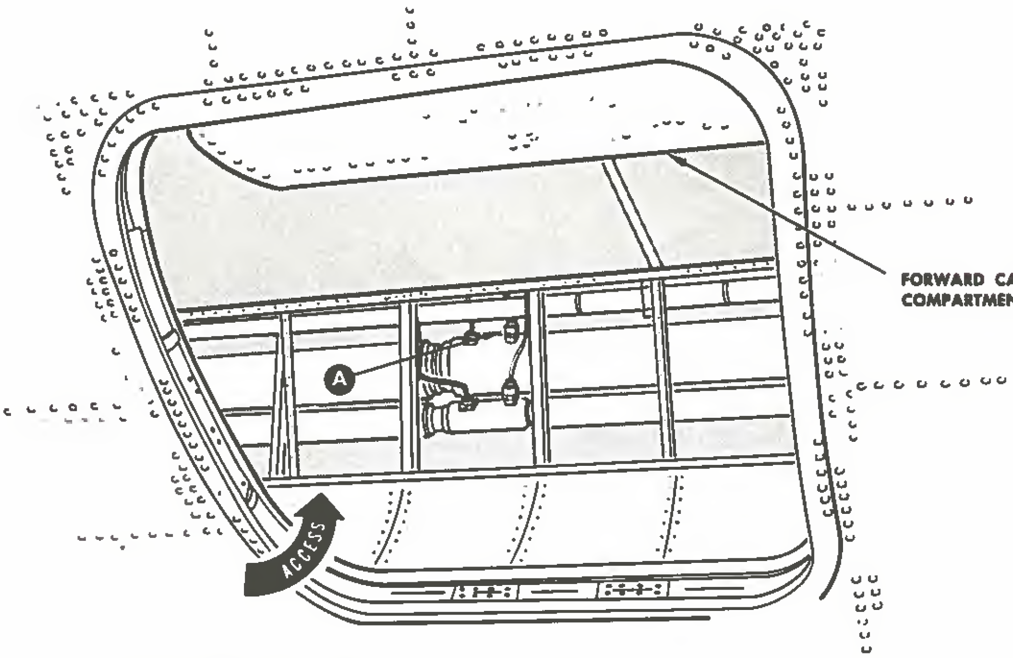
THERMAL SWITCH (160 DEGREES F) - DESCRIPTION AND OPERATION

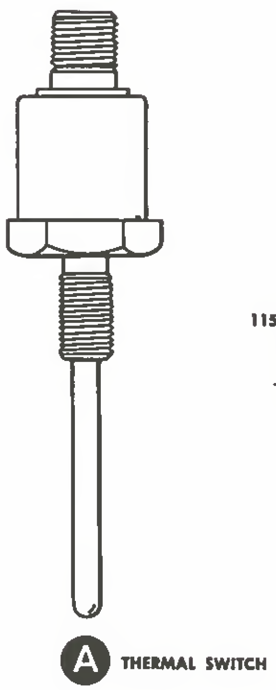
1. Description

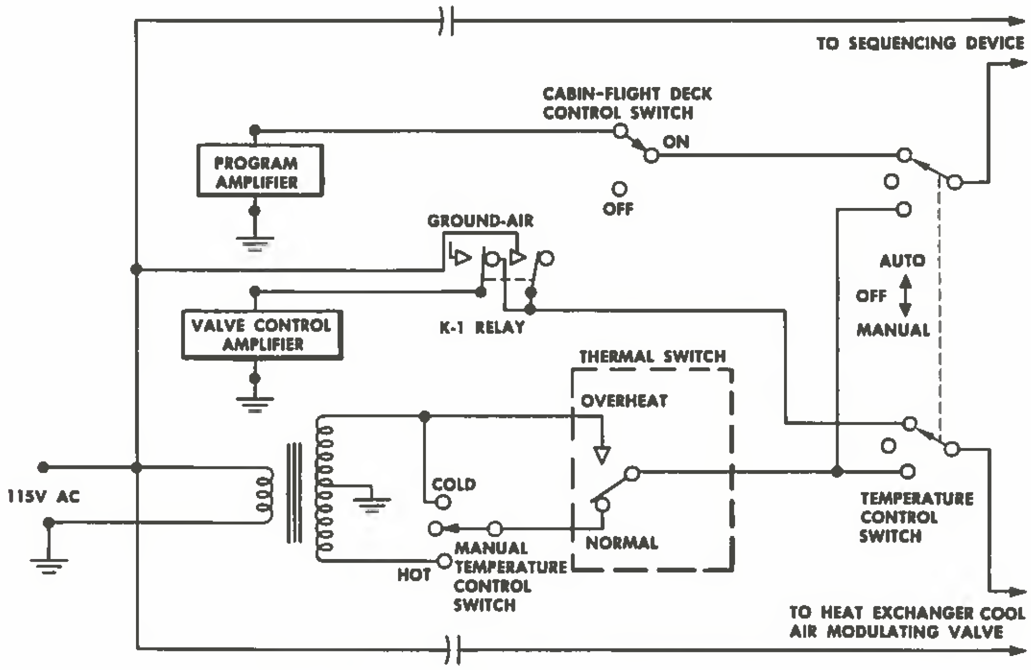
The 160 degree F thermal switch is a two position switch used for sensing duct temperature. See Figure 1. The switch has a normal position which it maintains at temperatures below 160 degrees F. When exposed to temperatures of 160 degrees F or greater, the switch closes its normally open overheat contacts. Upon cooling, it moves to its normal position.

2. Application

Application of the 160 degree F thermal switch in the control of the air conditioning and turbocompressor subsystem is only during manual operation. In the event duct temperatures exceed 160 degrees F during manual operation, the switch applies line voltage to the sequencing device and the cool air modulating valve to schedule cooling from the air conditioning subsystem.







22.02.21.200

Thermal Switch (160 Degrees F)
Figure 1

THERMAL SWITCH (160 DEGREES F) - MAINTENANCE PRACTICES

1. Removal/Installation Thermal Switch (160 Degrees F)

   A. Equipment Required - None.

   B. Preparation.

      (1) Open ELEC TEMP CONTROL circuit breaker. (Cabin or flight compartment as required.)

      (2) Enter forward cargo compartment and releaser liner fasteners on left bulkhead between stations 500 and 525. (On side opposite cargo compartment door and about one foot aft of door.) Open liner for access to thermal switch.

   C. Remove Thermal Switch (160 Degrees F).

      (1) Disconnect electrical connector from thermal switch.

      NOTE: Thermal switches are located on top of conditioned air ducts near the thermal resistors. The large duct contains the cabin thermal switch and the small duct contains the flight compartment thermal switch.

      (2) Unscrew thermal switch from the conditioned air duct.

      CAUTION: USE WRENCH ON WRENCH-FLAT PROVIDED ON DUCT MOUNTING BOSS TO COUNTERACT TORQUE WHEN LOOSENING THERMAL SWITCH.

      (3) Remove thermal switch and gasket from duct.

   D. Install Thermal Switch (160 Degrees F).

      (1) Locate mounting position of thermal switch (see note above).

      (2) With gasket in place, insert thermal switch into duct and screw in to tighten.

      CAUTION: USE WRENCH ON WRENCH-FLAT PROVIDED ON DUCT MOUNTING BOSS TO COUNTERACT TORQUE WHEN TIGHTENING THERMAL SWITCH.

      (3) Connect electrical connector to thermal switch.

      (4) Close cargo compartment lining.

      (5) Close ELEC TEMP CONTROL circuit breaker.

2. Adjustment/Test

   A. General.

(1) A functional test of the thermal switch (160 degrees F) after installation in the airplane is not practicable. The following test may be performed with the thermal switch removed from the airplane.

B. Equipment Required.

(1) A liquid or air bath having a variable temperature over the range of 140 to 170 degrees F.

(2) An ohmmeter.

(3) A calibrated thermometer.

C. Preparation.

(1) Remove thermal switch from airplane (refer to Removal/Installation).

(2) Heat liquid or air bath to 140 degrees F.

D. Test Thermal Switch.

(1) Immerse thermal switch probe in liquid or air bath and heat it to 140 degrees F.

(2) Perform continuity checks with ohmmeter:

(a) There shall be continuity between terminals A and C.

(b) There shall be no continuity between terminals B and C.

(3) Raise temperature of liquid or air bath to 170 degrees F.

(4) Perform continuity checks with ohmmeter.

(a) There shall be continuity between terminals B and C.

(b) There shall be no continuity between terminals A and C.

(5) Lower temperature of liquid or air bath to 140 degrees F, and repeat step (2) above.

<u>NOTE</u>: Thermal switches which do not operate in the range of 150 to 170 degrees F on either increasing or decreasing temperatures shall be replaced.

(6) Install thermal switch (160 degrees F) in airplane (refer to Removal/Installation).

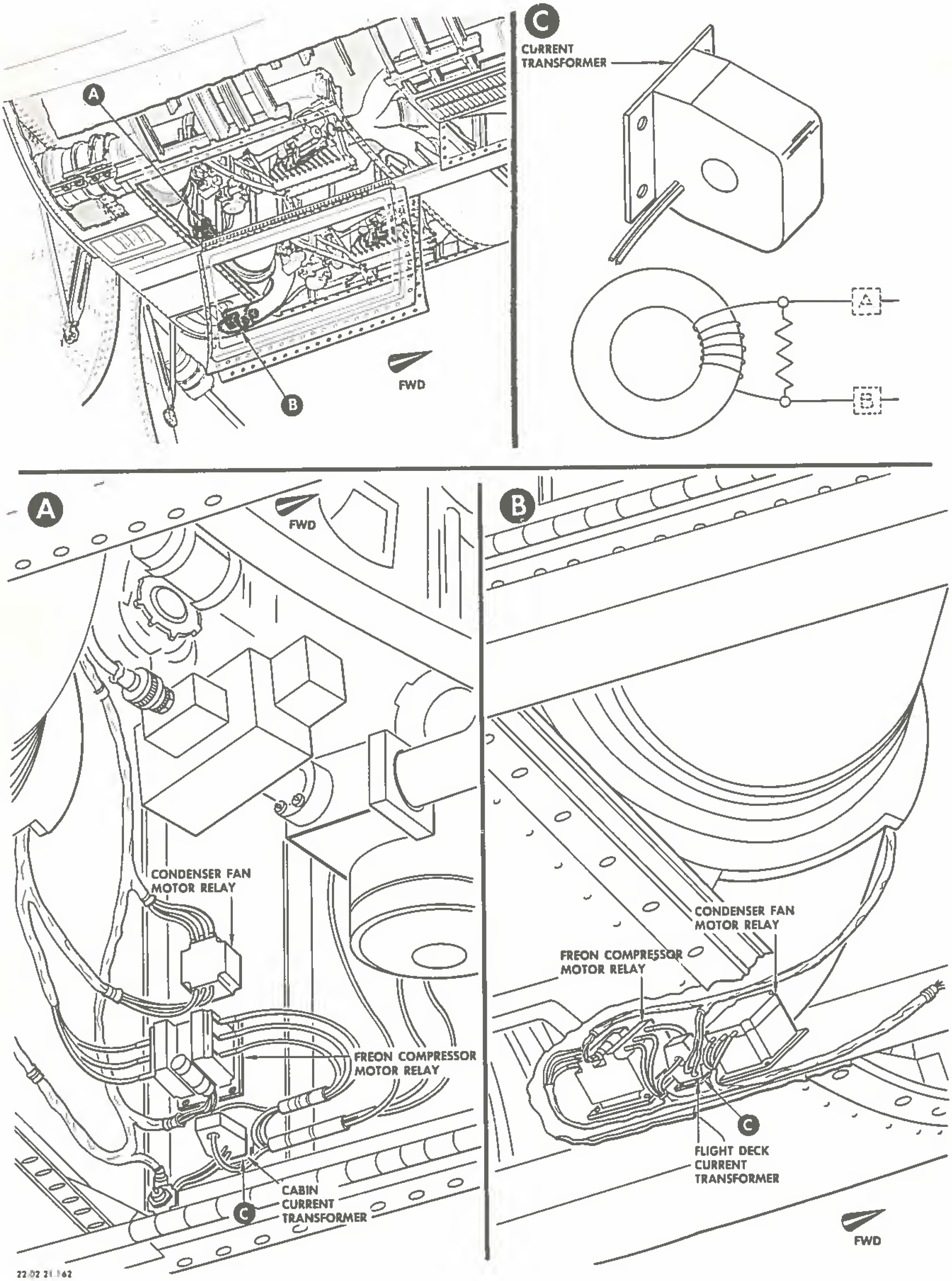
CURRENT TRANSFORMER - DESCRIPTION AND OPERATION

1. Description

The current transformer, shown on Figure 1, consists of a centrally bored box with mounting flanges on one end. Internally, an iron core encircles the hole. A coil connected to leads that protrude from the box is wrapped around the core. The flange has four holes which accommodate the mounting bolts to secure the box to the airplane structure.

2. Operation

A Freon compressor motor lead passes through the central bore. When current is used by the motor, an induced current flows from the coil. This current is proportional to the current supplied to the compressor motor. If compressor motor current becomes excessively high, the signal from the current transformer causes the Freon back pressure control to start closing the back pressure regulator valve, thereby reducing the back pressure in the main Freon loop. When the back pressure is reduced, the load on the compressor motor is reduced, and there is a corresponding reduction in compressor motor current.



Current Transformers
Figure 1

CURRENT TRANSFORMER - MAINTENANCE PRACTICES

1. Removal/Installation Current Transformer

A. Equipment Required - None

B. Preparation

(1) Open FREON SYS CONT circuit breaker (cabin or flight compartment as required). Place warning tag on open circuit breakers.

CAUTION: WHEN REMOVING THE CABIN (RH SIDE) CURRENT TRANSFORMER REMOVE THREE 70 AMPERE FREON COMPR AIR COND HTRS FUSES FROM THE NO. 2 ESS AC BUS.

WHEN REMOVING THE FLIGHT COMPARTMENT (LEFT SIDE) CURRENT TRANSFORMER, REMOVE THREE 70 AMPERE FREON COMPR AIR COND HTRS FUSES FROM THE NO. 4 NON ESS AC BUS.

DO NOT OPEN THE AC POWER DISTRIBUTION PANEL WITH THE BATTERY ON, THE ENGINES RUNNING, OR WITH EXTERNAL POWER CONNECTED TO THE AIRPLANE.

(2) Open Freon package access door (cabin or flight compartment as required).

C. Remove Current Transformer.

(1) Locate current transformer near the aft left side of Freon package next to the compressor motor relay. One power lead to the compressor motor passes through the core of the current transformer.

(2) Disconnect small electrical leads from the current transformer. (Tag for installation.)

(3) Disconnect the compressor motor power lead which passes through the current transformer.

(a) Unscrew terminal cap on compressor motor.

(b) Remove bolt which secures power lead to motor terminal.

(4) Remove four mounting screws which hold the current transformer in position. (Tag for installation.)

(5) Slide current transformer off end of power lead.

D. Install Current Transformer.

(1) Insert compressor motor power lead through hole in current transformer, and slide transformer up on wire to mounting position near compressor motor relay.

(2) Install four screws to secure transformer in position.

(3) Connect compressor motor power lead.

(a) With terminal cap on power lead, connect to motor terminal with bolt and nut.

(b) Slide terminal cap up to motor and screw in. Torque terminal cap to between 100 and 150 inch pounds and install safety wire.

(4) Connect two small leads to current transformer.

(5) Install FREON COMPR AIR COND HTRS fuses, and close FREON SYS CONTROL circuit breaker (cabin or flight compartment as required).

(6) Perform operational check of air conditioning system (refer to 21-0, Maintenance Practices).

(7) Close Freon package access door.

2. Adjustment/Test Current Transformer

A. Equipment Required

(1) 500-volt dc megger.

(2) AC vacuum tube voltmeter which is accurate within one percent.

(3) 400 ($\pm$ 20) cps power source with current adjustable from 50 to 100 ($\pm$ 1) amperes.

B. Preparation.

Remove current transformer from airplane (refer to Removal/Installation).

C. Perform Dielectric Test of Transformer.

(1) Connect two transformer leads together.

(2) Connect one lead from megger to transformer leads connected in step (1); connect remaining lead from megger to transformer mounting base.

(3) A 500-volt dc megger check between the transformer leads and the mounting base shall indicate a minimum resistance of 10-megohms.

D. Perform Current Tranformer Performance Test.

(1) Insert conductor from adjustable power source capable of carrying 100-amperes through center of transformer.

(2) The current in the conductor shall be set to the values given in the Table following and shall develop the corresponding secondary output voltages.

TABLE

PERFORMANCE TEST LIMITS

PRIMARY CURRENT Amperes (± 1%) RMS	OUTPUT (SECONDARY) VOLTAGE Voltage (± 0.1) RMS
100	9.86
88	8.67
76	7.49

(3) Replace current transformer with new unit if requirements stated in preceding Table cannot be met.

3. Inspection/Check Current Transformer

A. Examine exterior surfaces of transformer.

(1) Check for visual damage to wires and connections.

(2) Check mounting screw for security.

(3) Note any damage to compressor motor cable.

4. Cleaning/Painting Current Transformer

A. Clean transformer with a cloth moistened with solvent, specification AMS 3160A.

(1) Remove any corrosion with crocus cloth.

B. Paint Transformer.

(1) Touch up mounting flange if paint damage exposes metal. Use one coat of primer, Specification AMS 3110C and one coat of black enamel, Specification MIL-L-6805.

FREON BACK PRESSURE CONTROL - DESCRIPTION AND OPERATION

1. Description

The back pressure control is mounted on top of the evaporator Freon outlet header near the aft frame of the Freon package. Two harness receptacles connect the back pressure control to the bellows control and the back pressure regulator valve. The control, shown in Figure 1, consists of a bridge circuit and a magnetic modulator between the bellows control transformer and the back pressure regulator valve. Both legs of the bridge contain equal rectifiers and resistors, and each leg is connected to opposite ends of a transformer coil. The rectifiers, resistors, transformer coil, magnetic modulator, and the amplifier are potted within the control housing.

2. Operation

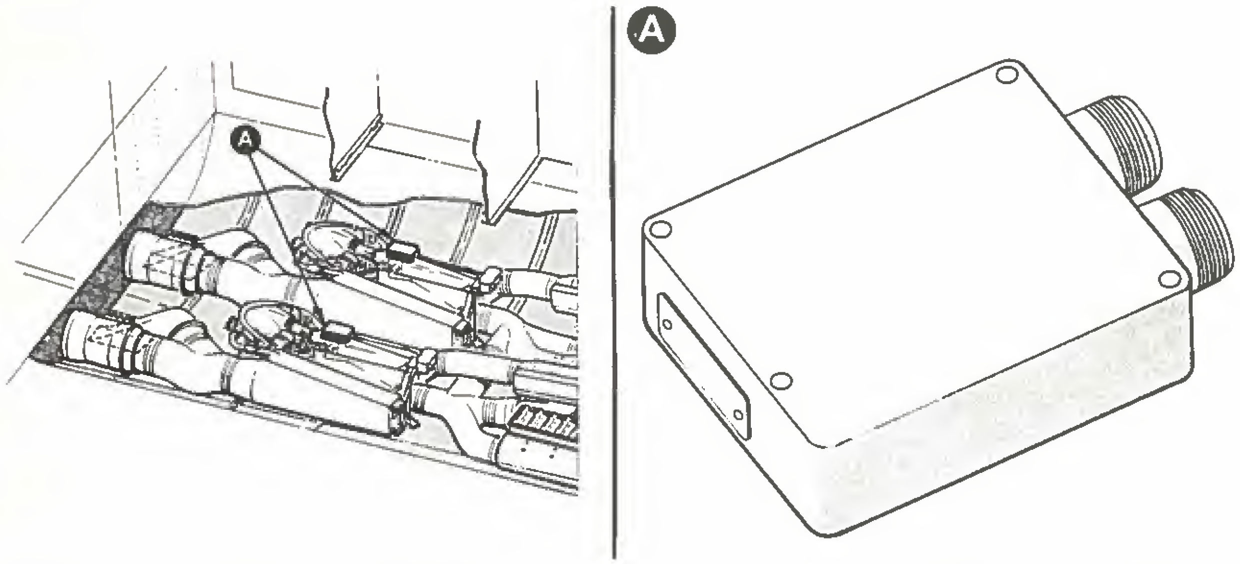
The back pressure control consists of the necessary circuitry to provide control of the back pressure regulator valve in response to signals from the bellows control and the current transformer. The bellows control provides the signal to the back pressure control for positioning the back pressure regulator valve to obtain the desired cooling capacity from the Freon package. A signal from the current transformer overrides the signal from the bellows control whenever the normal current load of the Freon compressor motor is exceeded. This signal to the back pressure controls starts closing the back pressure regulator valve to reduce compressor load and consequently reduce compressor motor current. The back pressure control contains a power supply, transistor amplifier, and magnetic modulator.

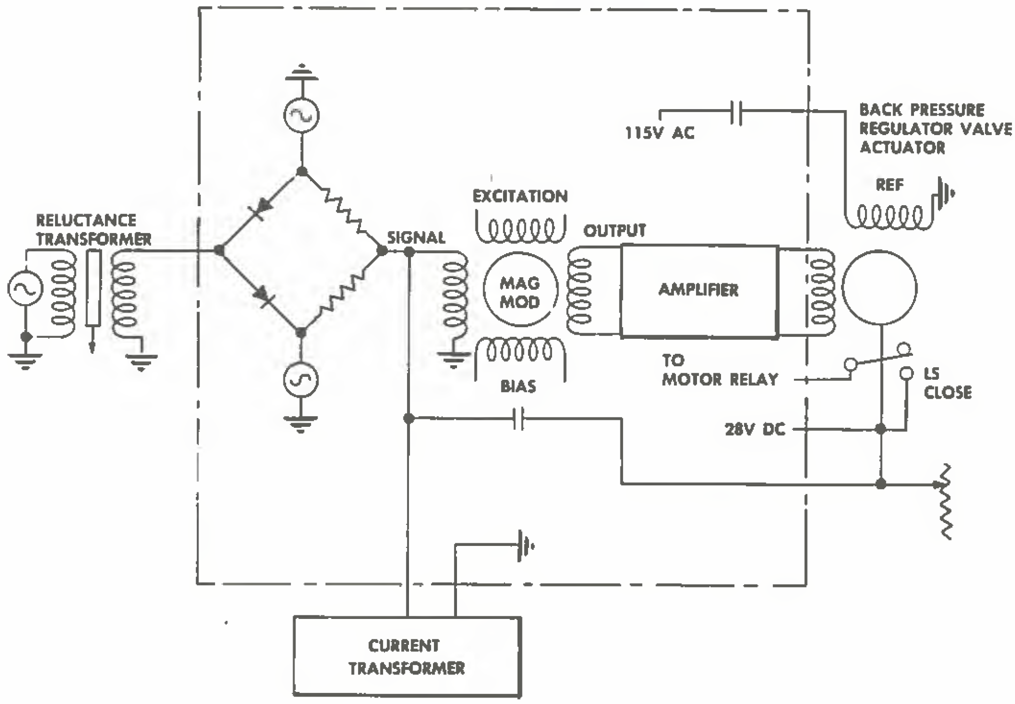
A. Magnetic Modulator.

The magnetic modulator contains input, output, bias, and excitation coils. An ac voltage is supplied to the excitation coil. This voltage is induced into the output winding provided the modulator is properly biased and properly supplied with a dc signal voltage. A dc current is applied through the bias coil to provide a modulator null voltage above ground. The dc input voltage (either plus or minus) will then shift the output ac signal by 180 degrees depending on whether the net magnetic modulator dc signal is above or below null. The level of the induced voltage from the excitation winding into the output winding is controlled by the current flow through the signal coil. The direction and amount of current flow through the signal winding will determine the phase and amplitude of the voltage from the output winding of the magnetic modulator.

B. Transistor Amplifier.

The output signal from the magnetic modulator is amplified by a two stage push-pull transistor amplifier. The transistors used are NPN





22.30.21.061

Freon Back Pressure Control
Figure 1

type for the first stage and PNP type for the second stage. Circuit application of the transistors in both stages is "common emitter." The input signal is applied between base and emitter with the output generated between collector and emitter. The output of the amplifier is applied to the control phase winding of the back pressure regulator valve.

C. Phase Shifting.

The reluctance transformer in the bellows control is supplied with an ac voltage to its primary winding. The position of the transformer core determines the phase of the voltage obtained from the secondary windings. At the normal operating position of the bellows control (where the variable spring pressure equals evaporator pressure) the transformer is adjusted to be at null. Movement of the core above or below this null point provides the phase shifted voltage which is applied to the bridge detector circuit where the ac signal is rectified. The resultant voltage from across the bridge will be either positive or negative voltage depending on the phase voltage applied. The positive voltage results when the core of the reluctance transformer is lowered as when less cooling is scheduled. The resulting current flow through the signal coil of the magnetic modulator sets up a control phase voltage which closes the back pressure regulator valve. Conversely, when the core of the reluctance transformer is raised for increased Freon package cooling, a negative voltage results across the bridge detector. This voltage causes current flow through the signal coil of the magnetic modulator to set up a control phase voltage which closes the back pressure regulator valve.

D. Regulator Valve Actuator Speed Control.

To control the speed of the back pressure regulator valve actuator, the valve contains a rate feedback potentiometer. The movable contact of this potentiometer is capacitance coupled to the input coil of the magnetic modulator through a rectifier circuit. Full voltage is initially applied to the input coil of the magnetic modulator from the bridge detector. However, as the valve actuator starts to rotate, its potentiometer applies a voltage of opposite polarity to the input coil. This results in a regulation of its rate of travel, and permits maximum voltage to be applied to the valve actuator at the instant of start.

E. Limit Switch.

A circuit through the back pressure control connects the coil of the compressor motor power relay to a limit switch in the back pressure regulator valve. The limit switch completes a circuit for compressor starting, whenever the valve is in the closed position, that permits 28-volt dc power to be supplied to the compressor motor power relay.

A set of contacts on the compressor motor power relay shunts the valve limit switch once the relay has energized. Another contact set that closes whenever the compressor motor power relay is de-energized, applies 28-volt dc power to the signal coil of the magnetic modulator to close the back pressure regulator valve (when the compressor is shut down) by applying a closing signal to the control winding of the valve.

The output from the current transformer is rectified into a positive dc voltage and compared to a negative dc voltage. Whenever the current load of the compressor increases above a preset amount, the output positive voltage from the current transformer exceeds the negative comparison voltage. By means of a diode, this excessive positive voltage is applied to the input coil of the magnetic modulator to provide a signal to close the back pressure regulator valve and reduce compressor load at any time the current exceeds the maximum value allowed.

FREON BACK PRESSURE CONTROL - MAINTENANCE PRACTICES

1. Removal/Installation Freon Back Pressure Control (see Figure 201)

A. Equipment Required - None.

B. Preparation.

(1) Open ELEC TEMP CONTROL and FREON SYS CONTROL circuit breakers (cabin or flight compartment as required). Place warning tag on open circuit breakers.

(2) Open Freon package access door (cabin or flight compartment as required).

C. Remove Freon Back Pressure Control.

(1) Locate the Freon back pressure control; it is bracket-mounted on the top aft end of the Freon evaporator.

(2) Disconnect two electrical connectors from front end of control. (Cap connectors and receptacles. Tag for installation.)

(3) Remove four bolts which secure the control to the mounting bracket. (Bag and tag hardware for installation.)

NOTE: If there is not enough clearance overhead to completely remove the mounting bolts, raise the bolts just enough to clear the mounting bracket and slide the control off the bracket.

(4) Remove Freon back pressure control.

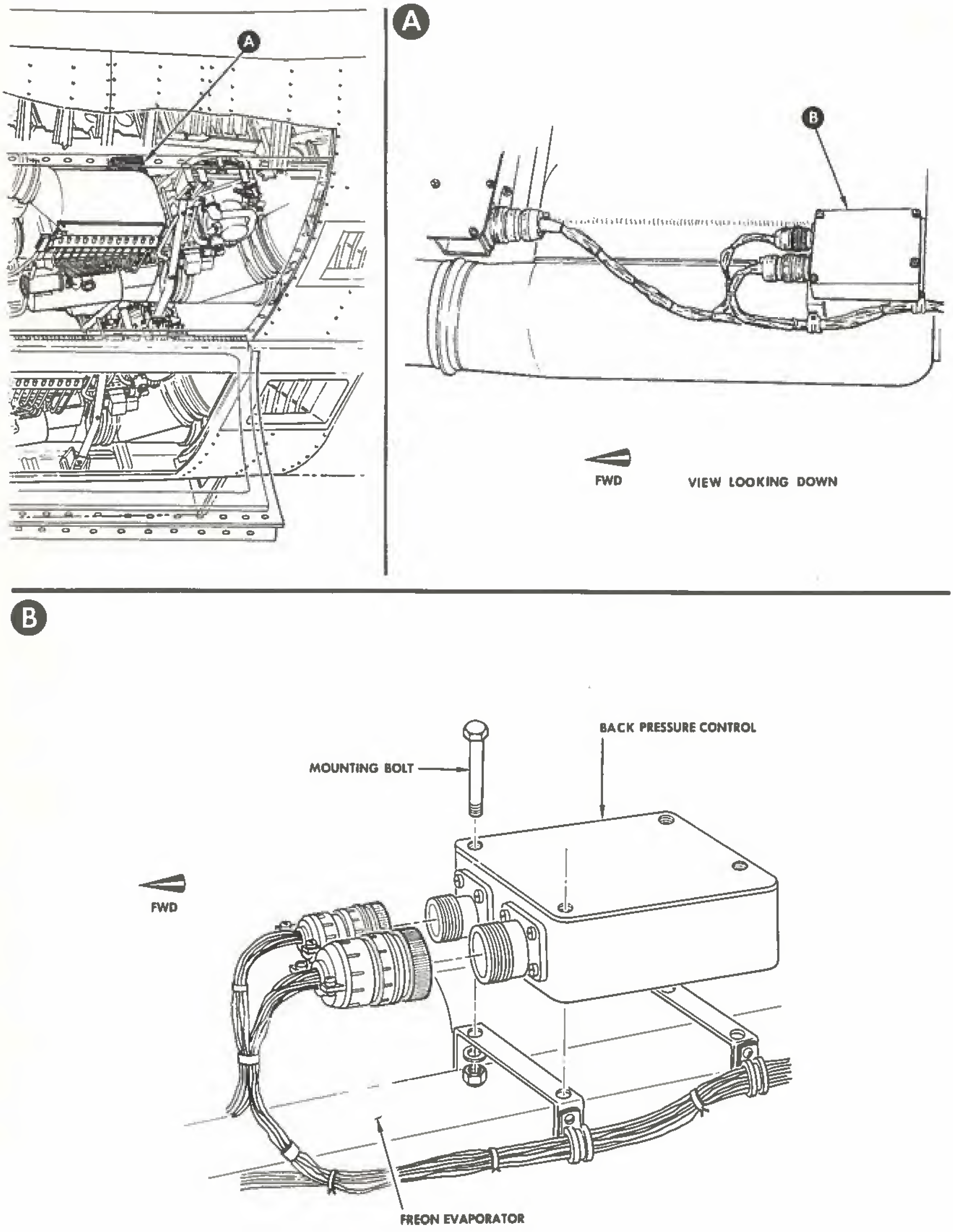
D. Install Freon Back Pressure Control.

(1) Position control on mounting bracket with electrical connectors forward. The large receptacle shall be on the left.

(2) Insert four mounting bolts through the top of the control and mounting bracket; secure bolts with washers and nuts.

(3) Connect two electrical connectors to control.

(4) Remove warning tags and close the ELEC TEMP CONTROL and FREON SYS CONTROL circuit breakers (cabin or flight compartment as required).



22 02.21.116

Freon Back Pressure Control Installation
Figure 201

(5) Perform operational check of air conditioning system (refer to 21-0, Maintenance Practices).

(6) Close Freon package access door.

2. Adjustment/Test.

A. Testing the back pressure control is accomplished through the use of BACK PRESSURE CONTROL SYSTEM TEST SET HS-7892 and CABLE ASSEMBLY HS-7901. See Figure 202. The back pressure control system test set will effectively accomplish the following:

(1) Indicate the position of the back pressure control valve.

(2) Indicate the bellows control is operating.

(3) Provide an indication of back pressure control operation.

CAUTION: IN STEP B. FOLLOWING, REMOVAL OF THE OUTPUT PLUG WITHOUT FIRST REMOVING THE INPUT PLUG WILL RESULT IN DAMAGE TO THE BACK PRESSURE CONTROL.

B. To connect test set HS-7892 into the back pressure control circuit, remove the input (small) and output (large) connector plugs from the back pressure control. Connect cable assembly HS-7901 between removed output plug (large plug) and output receptacle of control. The remaining connector of the cable assembly is then connected to the test set. Reconnect input plug (small plug) to apply power to the control after the test set has been connected.

(1) The checks are made with the air conditioning and pressurization systems operating in the normal automatic ground condition.

(2) Positioning of the sequencing device for full cold or full hot positions may be accomplished manually by toggling the switches in the airplane.

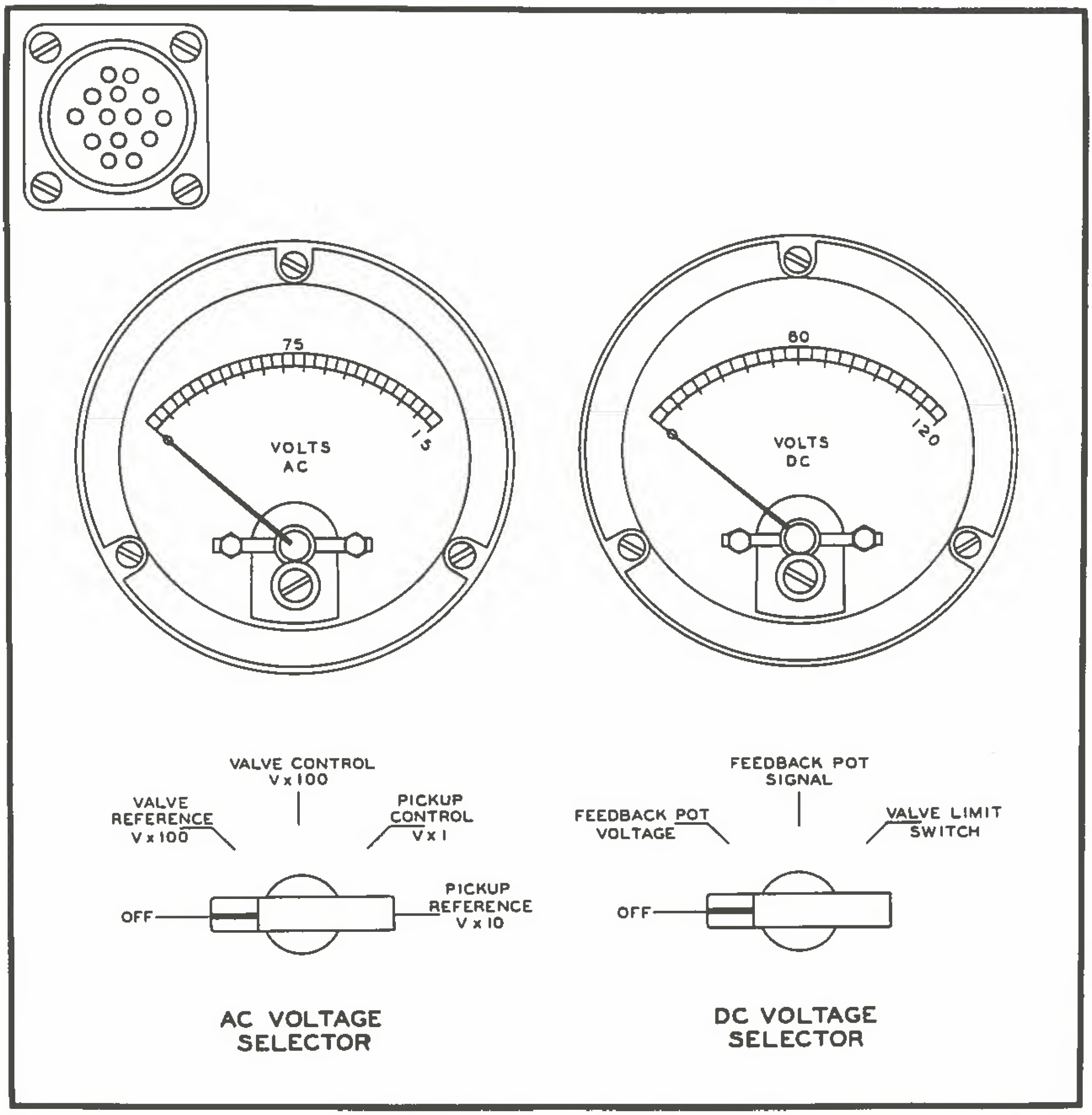
C. Determination of back pressure control operation with test set HS-7892.

(1) Reference voltage to back pressure regulating valve. Set test set as follows:

(a) AC VOLTAGE SELECTOR in VALVE REFERENCE position.

(b) DC VOLTAGE SELECTOR in OFF position.

The reading on the ac meter shall be 110 (± 20) volts.



22.03.21.133

Freon Back Pressure Control Test Set
Figure 202

(2) Reference voltage for bellows control pickup. Set test set as follows:

(a) AC VOLTAGE SELECTOR in PICKUP REFERENCE position.

(b) DC VOLTAGE SELECTOR in OFF position.

The reading on the ac meter shall be 14 (± 2) volts.

(3) Signal voltage from bellows control pickup. Set test set as follows:

(a) AC VOLTAGE SELECTOR in PICKUP CONTROL position.

(b) DC VOLTAGE SELECTOR in OFF position.

(c) Toggle sequencing device alternately from full cold to full hot positions.

The reading on the ac meter shall be 0.5 (± 0.2) volts at both the full hot and cold positions. A null point shall exist between the two extreme positions.

(4) Feedback potentiometer voltage for back pressure regulating valve. Set test set as follows:

(a) AC VOLTAGE SELECTOR in OFF position.

(b) DC VOLTAGE SELECTOR in FEEDBACK POT VOLTAGE position.

The reading on the d-c meter shall be 100 (± 20) volts.

(5) Control voltage to back pressure regulating valve and the monitoring of valve position.

(a) The position of the back pressure regulating valve is determined by monitoring the voltage from the valve feedback potentiometer wiper. The voltage across the potentiometer is 100 (± 20) volts, thus when the valve is closed the wiper is at the zero voltage end of the potentiometer and when open the wiper is at the 100 (± 20) voltage end of the potentiometer. Valve positions between full open and full closed are determined by correlating valve position with the voltage reading from the potentiometer wiper.

(b) Check control voltage to back pressure valve while monitoring valve position. Set test set as follows:

1) DC VOLTAGE SELECTOR in FEEDBACK POT SIGNAL position for monitoring valve position by voltage readings on the dc meter.

2) AC VOLTAGE SELECTOR in VALVE CONTROL position. Toggle sequencing device to a position which is midrange of the second quadrant and allow Freon package bellows control to null the control voltage to valve as indicated on the ac meter. When nulled, toggle sequencing device toward hot until at end of second quadrant. Observe 0 to 110 (±20) volts increase on the ac meter (and a decrease in voltage reading on the dc meter) as the valve travels toward close. Return sequencing device to midrange of second quadrant and permit control voltage to renull. Toggle sequencing device toward cold until at start of second quadrant. Observe 0 to 110 (±20) volts increase on the ac meter and an increase in voltage reading on the dc meter as the valve travels toward open. Permit control voltage to renull at full cold setting of sequencing device. If control voltage varies and valve does not open fully at full cold setting, the compressor may be operating at its full current limit. This is considered normal operation. Shut down Freon package and observe 0 to 110 (±20) volts increase on ac meter and a decrease in voltage reading on the dc meter as the valve closes.

(6) Back pressure regulating valve limit switch check. Set test set as follows:

(a) AC VOLTAGE SELECTOR in VALVE CONTROL POSITION.

(b) DC VOLTAGE SELECTOR in 28 VOLTS position.

(c) Toggle sequencing device to the full hot position then to the cold position until sequencing device enters second quadrant.

The dc meter should indicate 28-volts as the sequencing device enters the second quadrant from the third quadrant and the Freon compressor should start operating. The ac meter should show 110 (±20) volts during sequencing device travel through the third and fourth quadrants.

3. Inspection/Check.

A. Examine the exterior of the control for damage to the paint or cracks in the potting material.

(1) Determine if cracks in the potting have affected any electronic wiring, if so, replace the unit.

B. Check the electrical receptacles for distortion or other damage.

(1) Straighten receptacle pins carefully.

C. Check the retaining screws for security.

4. Cleaning/Painting

A. Clean the back pressure control.

(1) Clean the outer surfaces with a lint free cloth moistened with AMS 3160A solvent to remove grease or oil deposits.

NOTE: Do not immerse the control or allow solvent to enter the receptacles.

B. Paint the back pressure control.

(1) Mask off electrical receptacles and the identification plate.

(2) Apply a prime coat of zinc chromate, Specification AMS 3110, to the metal surfaces, to obtain a semi-transparent greenish coating.

(3) Allow the prime coat to dry 30 minutes at room temperature.

(4) Apply a coat of glyceryl phthalate black enamel, Specification AMS 3120B.

(5) Allow to dry at room temperature for 4 hours before installation.

5. Approved Repair.

A. Remove corrosion from exposed metal surfaces.

(1) Polish out with crocus cloth.

B. Replace retaining screws as needed.

TEMPORARY REVISION NO. 21-27.

Insert facing 21-4-10, Page 1 dated May 25/61.

This temporary revision is applicable to airplanes after incorporation of Service Bulletin 21-32.

21-4-10, Page 1 dated May 25/61 is applicable prior to incorporation of Service Bulletin 21-32.

CONDENSER COOLING AIR CUT-OFF PRESSURE SWITCH - DESCRIPTION AND OPERATION

1. Description

The condenser cooling air pressure switch is a single pole, double throw, pressure operated, snap-action type switch. The switch and pressure unit are contained within a cylindrical housing which is approximately three inches in diameter and one and one half inches long. The cylinder contains a series of ram air pressure breather holes and an electrical receptacle on one end, and an ambient air pressure sensing port on the opposite end. The pressure switch is located outboard of the flight deck Freon package and senses ram air pressure in the air conditioning compartment.

2. Operation

When the airplane is in cruising flight, and ram air maintains compartment pressure above 0.50 (±0.07) psig, there is sufficient condenser cooling from ram air flow. However, when ram air pressure drops below approximately 0.5 psig, such as during a landing approach, the condenser cooling air pressure switch actuates. When the switch actuates it routes 28-volt dc power to energize the condenser cooling control relays. The LH condenser cooling control relay, when energized, routes 115-volt ac power to close the condenser cooling air modulating valve, open the condenser ground cooling shutoff valve and start the condenser fan for the flight compartment air conditioning system. The RH relay performs the same function for the cabin air conditioning system. Thus, a constant source of cooling air, either from ram air flow or from fan induced airflow, is provided to cool the Freon condenser when cooling is scheduled for the air conditioning system.